THE ILLUMINATING ENGINEER
THE JOURNAL OF GOOD LIGHTING
LIGHT LAMPS FITTINGS AND ILLUMINATION
OIL GAS ELECTRICITY ACETYLENE PETROL-AIR GAS ETC.
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Standardization in Illuminating Engineering

THE meeting of the Illuminating Engineering Society on February 25th served a useful purpose in bringing before members the exceedingly valuable work that the B.E.S.A. has been doing in connection with standardization in illuminating engineering, and affording an opportunity for the discussion of the specifications so far issued. An account of the proceedings will be found on pp. 69-76. In his introductory address Mr. P. Good detailed the circumstances leading to the Conference called in January, 1924, when the decision to form a Sectional Committee to deal with standardization in illuminating engineering was taken. It is surely a significant sign of progress that the time should be considered ripe for such a step, and Mr. Good's report shows that in the two years that have since elapsed much useful work has already been done. Three reports dealing with specifications for portable photometers and industrial reflector-fittings, and the glossary of terms used in illuminating engineering, have been issued. Accounts of these three pieces of work were given at the meeting by Lieut.-Col. Edgcumbe and Mr. Haydn T. Harrison, the respective chairmen of the committees on portable photometers and reflectors, whilst Mr. P. Good dealt with the glossary. Three other investigations, dealing respectively with illuminating glassware, street-lighting, and photometric integrators, are now proceeding.

The Standard Specification for Portable Photometers.

Lieut.-Col. Kenelm Edgcumbe's analysis of the specification for Portable Photometers shows that in many respects this deals with new ground. The specification, in fact, may be regarded as partly educational, as it brings out many points not generally appreciated. To those not familiar with the difficulties of measurements of illumination the recommended margin of accuracy, ±15 per cent., may seem high. But when all the possible sources of error are taken into consideration it is not excessive. Such a degree of accuracy would answer for practical purposes, as the variations in illumination to be studied there are of the order of hundreds per cent.—for instance, it is by no means uncommon to find in one factory illuminations two or three times as high as that used in another for substantially the same process.

Special interest attaches to the care with which the Committee have studied electrical connections, and their recommendations should go far towards eliminating intermittent contacts, which are particularly liable to cause errors in low-voltage circuits for small electric lamps. One point brought out very clearly in the specification is the importance of the test-surface, on which illuminations are received. Even under the best conditions, such surfaces do not act as perfect diffusers, so that for very oblique light rays errors are liable to occur. If such surfaces are not kept clean or allowed to become partially polished the liability to error is naturally much increased. This consideration emphasizes the desirability of some appliance for indicating the angle at which light-rays are received at the test-surface—a device which is also useful in tests of street-lighting, and in other circumstances when it is desired to determine the candle-power of a source in some particular direction.

We have no doubt that the effect of the specification will be to stimulate improvements in photometric instruments and raise the general standard of reliability and accuracy. In the course of the discussion the embodiment of some improvements designed to enable the Holophane Lumeter to comply with the specification was described, and we understand that new and improved forms of other models will be introduced shortly.

Specification for Industrial Reflector Fittings.

The other specification, dealing with industrial reflector fittings, also marks a distinct step forward. The clause which aroused most discussion was, as might be expected, that dealing with the "angle of cut-off." Manufacturers of reflectors fully endorse the importance of eliminating glare from exposed filaments, and the recommendation that the angle of cut-off should be 20°, thus conforming with the recommendations of the Home Office Departmental Committee on Lighting in Factories and Workshops, is a significant indication of the trend of modern opinion. There are naturally various ways in which the recommendations of the Home Office Committee can be met. A consumer might, for instance, use relatively shallow reflectors with a smaller angle of cut-off, if they are mounted at a great height, so as to be well outside the direct range of vision; the angle drawn between a line drawn from the eye to the filament and a horizontal plane might still be not less than 20°. But the advantage of adopting 20° for the cut-off angle of the reflector itself is that we then obtain a unit which can be used in any position (not less than six feet from the operator), without departure from the conditions limiting glare.

From the manufacturing standpoint the design of such reflectors presents no great difficulties. One can recall successful industrial lighting installations in which a high general illumination is provided, and

not a single filament is visible to a worker looking across the room. It is evident, however, as pointed out in the discussion, that the successful use of a standardized reflector of this description assumes that lamps are also manufactured to specification. Thus, the design and dimensions of lamps should be such that they do not project outside the reflector, and that the filament is confined to a definite position with respect to the cap of the lamp, and is therefore located at the predetermined point in the standardized reflector.

We have reason to believe that the leading lamp-makers fully realize the importance of this point. Considerable progress towards lamp standardization has recently been made, as is indicated by the values for dimensions of bulbs and mean light-centre length set out in the B.E.S.A. Specification No. 161—1924. Further progress in this direction will be very helpful to the lighting industry, and we understand that the effect of distance between centre of filament and the cap of the lamp is now being very carefully studied, with a view to fixing definitely the limits of variation tolerated in practice.

On another point—the relation between the design of reflectors and "efficiency"—the specification has helped to clear up preconceived ideas. The efficiency of a reflector is usually taken to mean the ratio between the actual flux of light emitted by a lighting unit and the total flux of light furnished by the lamp. Now it is quite clear that some sacrifice in the efficiency, thus defined, is necessary in order that a reflector may fulfil its functions satisfactorily.

In general, the greater the proportion of its light intercepted by the reflector-surface, the greater the loss of light through absorption is apt to be. It has been suggested that the adoption of an angle of cut-off of 20° may cause the efficiency to be somewhat less than that of reflectors of a shallower type.

But the advantages of proper screening of the light source and efficient distribution of light more than compensate for this. Even so, the realizable efficiency is stated to be not less than 60 per cent.—which is much greater than that obtainable from many reflectors of inferior design at present in use.

We understand that investigations into the question of the effect of angle of cut-off on "glare" are still proceeding, and there are various devices, such as the use of diffusing bands, etc., which deserve consideration. The recommendations in the report of the Home Office Committee were made after very careful investigation, and they are so framed that quite a number of different methods of meeting requirements are possible. We are, however, glad to observe that, so far as reflectors of the standard enamelled-iron variety are concerned, expert opinion strongly endorses the adoption that the angle of cut-off should not be less than 20°.

The final paper, by Mr. Good, dealt with the Glossary of Terms used in Illuminating Engineering. Agreement on such definitions is of very great importance in illuminating engineering, and the attention of writers of text-books and articles may be drawn to this list (No. 233—1925), which should be adhered to in current literature.

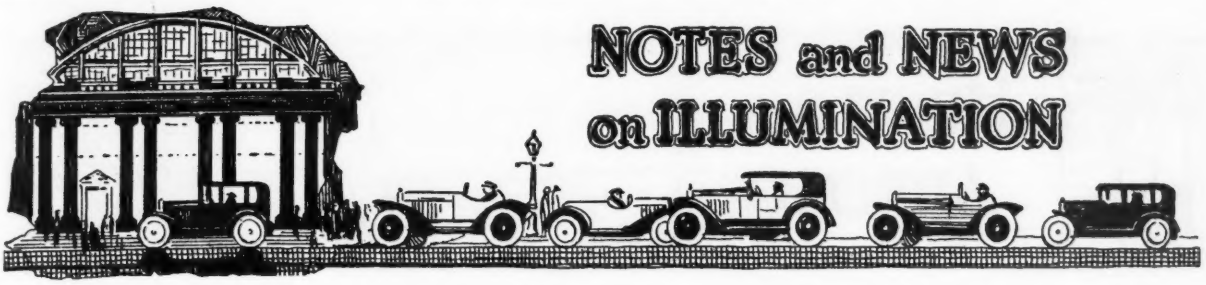
The three reports so far issued give evidence of great care and patience, and the members of these committees who have given so much of their time to this work in an honorary capacity deserve the gratitude of the lighting industry and the public. We trust that one result of the meeting of the Illuminating Engineering Society will be to enlarge the circle of those familiar with the valuable work which the B.E.S.A. and its committees are doing, and which its thoroughly representative and authoritative constitution enables it to do extremely well.

Mr. Trotter's Faraday Lecture

AS promised in our last issue, we are enabled, through the courtesy of Mr. A. P. Trotter and the Institution of Electrical Engineers, to give a summary of the Faraday Lecture on "Illumination and Light," delivered at Liverpool, Manchester, Dublin and Cardiff. The first portion of the lecture, dealing with illumination, is very fully reproduced; the latter part, devoted mainly to speculations on the theory of light, is more condensed. Mr. Trotter deals with the subject in his inimitable way—recalling the remarks he used to address to us as President of the Illuminating Engineering Society. He surveys progress in lamps and lighting from the days of Faraday onwards, recalling some personal experiences. (Mr. Trotter only just missed seeing Faraday himself! He began to attend the juvenile Christmas lectures at the Royal Institution in 1886; Faraday died in the following year.) Mr. Trotter shows how during the past 20 years Illuminating Engineering, a new field of special knowledge, has developed. He traces the work of the Illuminating Engineering Society and summarizes recent developments in factory lighting, the artificial daylight and the study of natural lighting in picture galleries, offices, factories, etc.

The lectures were illustrated by a series of experiments. Mr. Trotter showed two portraits of Faraday and large tracings of lines of force from magnets concealed under paper. The demonstrators at local colleges co-operated by producing some fine large-scale exhibits of spectra (that at Liverpool was 10 ft. long). A demonstration was given of the Rumford photometer, and the illumination in different parts of the halls was measured, various lamps being turned on and off. Another attractive demonstration was the illumination of a pair of coloured posters of scenery, furnished by Mr. A. Cunnington, of the Southern Railway, one of each pair being illuminated by ordinary lamps, the other by artificial daylight. These were kept on for several minutes with the general lighting turned down, giving the audience an opportunity to compare the effects. The lectures furnished a striking example both of the interest in illumination and of Mr. Trotter's "drawing power." At Liverpool and Manchester there were large audiences, and at Dublin and Cardiff practically every seat was filled.

We have taken the opportunity to include in this issue a biographical note on Mr. Trotter's activities (p. 77). For many years as electrical adviser to the Board of Trade, he did valuable service; but it is through his independent researches carried out in his private laboratory, and devoted almost entirely to photometry and illumination, that he has come to be regarded in this country as the "father of photometry" as practised to-day. The writer's recollections of Mr. Trotter go back to about thirty years ago, when he was introduced to him by the late Professor Silvanus P. Thompson. Mr. Trotter had then been experimenting with the electric arc, and listened with sympathetic and kindly attention to the writer's suggestions for the improvement of carbons. Some years later Mr. Trotter presided over the gathering when the starting of *The Illuminating Engineer* was announced and the formation of the Illuminating Engineering Society discussed. Professor Silvanus P. Thompson became the first president of the Society; he was followed in 1917 by Mr. Trotter, who, in his Faraday Lecture, has once more given evidence of his belief in the wide scope and great future of illuminating engineering.



Discretion in the Use of Artificial Sunlight

The considerable amount of public interest taken in "artificial sunlight" treatment was illustrated by the exhibition of appliances held during this month at the Middlesex Hospital. To those not in touch with this movement it may come as a revelation to find how many firms are specializing in apparatus of this type. At the same time it is becoming increasingly recognized that the application of this new treatment needs care. Dr. Percy Hall, who delivered a lecture in connection with the opening of the exhibition, described solar-ray treatment as one of the greatest discoveries of the last generation, and predicted important future developments. Nevertheless he emphasized the need for caution in the use of this new treatment, which should only be conducted under the guidance of the medical profession.

Institution of Public Lighting Engineers
Third Annual Conference

We observe that at the third annual meeting and conference of the Institution of Public Lighting Engineers, which is this year to be held in Newcastle-on-Tyne, arrangements will be made for an exhibition of lighting appliances, gas and electric. The exhibition will be opened by the Lord Mayor of Newcastle, and will remain open during the three days of the conference, viz., September 14th, 15th and 16th. Firms desirous of exhibiting should apply to Mr. R. Davidson (President-elect), Public Lighting Superintendent, Corporation Lighting Department, Blagdon Street, Newcastle-upon-Tyne, stating the amount of space required, and whether gas or electric current will be needed in connection with their exhibit.

The North-East Coast Lighting Service Bureau

From information received it appears that the above Bureau has made a good start, and had a successful season. Numerous lectures on illumination have been given before Institutions, Newcastle shopkeepers, Girl Guides, Domestic Science Colleges, Chambers of Trade and Commerce, etc., in the North Coast area. During the present month an exhibit was made at the Thirsk Electrical Exhibition, and on Friday, March 12th, a lecture to shopkeepers was delivered at the exhibition by the District Engineer, Mr. E. S. Evans.

Festive Illuminations at Selfridge's

The hanging curtains of small electric lamps, which were shown burning during the "Birthday Week" at Selfridge's this month, form a novel method of decorative lighting. In the ordinary course a display of this kind would be apt to be glaring, but owing to the size and height of the building the mass of small lamps used does not strike one in this way. The small lamps are interlinked with a blue decorative background, making a pleasing contrast. The luminous curtains have been on view during the daytime, when the effect is, if anything, rather better than at night, as the blue element in the decorative scheme shows up well. This furnishes another illustration of the practice of using artificial light for display purposes during the daytime, which seems likely to become more usual in the future.

Street Lighting in Leicester

From the annual report of Mr. Thomas Wilkie, the lighting superintendent in Leicester, it is evident that the public lighting of this city has been the subject of special attention during the past year. During the past three years the cost of public lighting has diminished from 5·73 to 4·87 d. per £. Yet the lighting conditions have been improved. As regards the gas-lighted section of the city the improvement is due largely to the substitution of three-light Bijou superheated burners for the obsolete 10ft. and 9ft. types. The former yield over 32 c.p. per cub. ft. per hour, as compared with 20 given by the latter. In spite of the addition of 131 lamps the total cost of gas for the year is less by £263. The total candle-power yielded by low pressure gas lamps was 641,945 in 1925 as compared with 467,393 in 1923. Owing to better conditions of maintenance with the new burners the number of mantles used per annum during the same period has been reduced to less than half; it now averages 3·86 mantles per burner per year.

In the Electric Lighting Section the maintenance of all but three installations is now done by the department. During the year eighty-three additional lamps were lighted. The total candle-power of public street lamps was last year 74,730 as compared with 50,250 in 1923. The lighting of two important junctions, comprising a double arm standard with a 500 W. lamp on each, mounted 20 feet high and equipped with band refractors, has now been completed. It is stated that the result "is such as to render impossible, through insufficient lighting, a recurrence of the many accidents at these spots."

The lettering of streets is now to be supplemented by fixing lettered panes to street-lamps. Some of the lighting is controlled by time switches but a tribute is paid to the very efficient work of the staff of lamp-lighters during the year, when the total loss of time amounted to less than two hours.

The Electrical Industry and the Architect

At the fifth E.D.A. Conference on February 19th, Mr. G. Blair Imrie, as an architect, referred to some difficulties encountered by architects when dealing with the installation of electricity, emphasizing especially the complexity of some tariffs, the need for simplification of wiring rules, and the delay in getting consumers connected. Other points mentioned were the convenience of flush switches and the unnecessarily large size of plugs for power circuits. Mr. Rawlings pointed out that proper wiring regulations were a necessity for sound work. Mr. F. C. Raphael suggested that electrical contractors should not be left to prepare a schedule for the architect when a consulting engineer was called in. In some cases buildings were designed without any consideration as to where cables carrying electric cables were to go. Mr. L. Gaster emphasized the valuable service which the architect could render in securing the provision of good lighting, and suggested that the help of a consulting electrical engineer should be sought in the case of buildings of importance. Mr. Gaster also said a good word for supply undertakings; he could not help thinking that the author, having had one unfortunate experience, had been misled into thinking that all undertakings were the same! The E.D.A. has done good work in promoting this conference, which afforded an opportunity for architects and electrical engineers to compare notes on their respective difficulties, and see what they can do to help each other.

Proceedings of the International Illumination Commission

We are including in this issue (p. 94) a review of the very complete account of the proceedings at the meeting of the International Illumination Commission (held in Geneva in July, 1924), now issued by the Cambridge University Press. This is an imposing record of work done, and the papers cover a wide ground. An important feature is the inclusion of a series of papers dealing with the education of the public in illumination and describing the methods of work of central stations and distributing engineers, working in co-operation with manufacturers in the United States. We have no doubt that when the next gathering of the International Illumination Commission is held there will be a yet greater volume of information on developments in various countries to be presented.

Illuminating Engineering in Italy

We notice that Italy, in common with other countries, is taking an active interest in illumination. Articles dealing with lamps and lighting appliances frequently appear in *L'Elettrotecnica*, an instance being the recent contribution of Sig. G. Peri on the conditions affecting the life of tungsten lamps. A sign of progress is the creation of the National Association for the Study of Illumination, formed on the initiative of Sig. Motta e Ponti, and other leading representatives of the electrical industries in Italy. The new body will devote attention especially to the promotion of public appreciation of the benefits of good illumination, and the discussion of its relation to health and efficient production. The Association's headquarters will at present be located with the Società Edison, the President being Sig. Motta, whilst its activities will be under the direction of Sig. C. Clerici, who is devoting himself to the study of problems in illumination.

A "Better Lighting" Campaign in France

A few months ago we referred to the development of a "better lighting" movement in France. This has now crystallized in the Société pour le Perfectionnement de l'Eclairage, with headquarters at 12, Rue Pelleport, Paris. The new organization receives the support of leading electrical supply undertakings and makers of electric lamps in France. Its objects include the collection and dissemination of information on illumination, the training of demonstrators and the organization of a campaign in favour of better lighting. It is intended to establish a demonstration-room and to publish a journal under the title of *L'Eclairagisme*.

A Bibliography of Industrial Hygiene

An example of the useful work being done by the International Labour Office of the League of Nations at Geneva. The issue before us contains some hundreds of references, all classified under headings, the latter given in French, English and German. A section is devoted to lighting: this includes a number of recent papers and articles on industrial illumination, a considerable proportion of which have appeared in *The Illuminating Engineer*.

Propaganda on Public Lighting

In a recent contribution to *The Electrical World*, Mr. G. H. P. Dellman suggests that in America so-called "ornamental street lighting" is apt to be overdone. Some of the forms of globes used are encouraged because the glass appears to be beautifully filled with light. The resultant diminution in glare is doubtless an important consideration, but the amount of light absorbed is sometimes unnecessarily high. The central station is not doing its duty when it acquiesces in the continued use of inefficient lighting units on the ground that the revenue derived is just as much as if more efficient lighting units were substituted! The most difficult task for the central station, however, is the sale of utilitarian lighting such as is needed in the majority of streets. Reference is made to the decision of the street-lighting committee of the Pacific Coast Electrical Association, which, in its report last year, recommended that units of less than 2,500 lumens should not be used for public lighting. The writer asks why it is that people complain of taxes. "Is it because they are really a burden or because they do not understand for what purpose the money raised by taxation is spent? Most households spend two or three times as much for gas or electricity in their homes as they do for the service rendered by the municipality, and yet do not complain. The difference is that in the one case they see what they are getting for their money and in the other they do not. City authorities do not take the trouble to analyse the budget for the benefit of the taxpayer. Street-lighting appropriation, however, is an item that can easily be explained and justified, and it is the duty of the light and power industry to see that the public demands street-lighting appropriations consistent with the needs of the community."

New Forms of Carbons for Projectors

Much attention has been given during recent years to the production of special carbons giving a higher crater-brightness, and therefore valuable for use with projectors and searchlights. The designs are based mainly on a central core of rare earths, notably salts of cerium or titanium mixed with carbon. In *The Revue Générale de l'Electricité*, Monsieur J. Rey, who has been responsible for many investigations on searchlights, describes some tests made during 1924 and 1925.

The maximum brightness then recorded was 539 candles per square millimetre, the average crater-brightness being 296 candles per square millimetre. Different zones of the crater vary in brightness, and it is important to draw a distinction between maximum and average values. Measurements require care, and Monsieur Rey believes that some estimates made abroad are excessive. Values exceeding 1,000 candles per square millimetre have been reported, whereas the highest values obtained by the author (with some of the latest German carbons operating at 200 amps., with a positive of cerium oxide) gave a maximum brightness of 887 candles per square millimetre, and an average of 458. Amongst other points to be noted are the influence of the flame, which may be responsible for 36 per cent. of the total light, and the difference in diameter of the crater when measured respectively in the hot and the cold state.

TECHNICAL SECTION

COMPRISING

Transactions of The Illuminating Engineering Society and Special Articles

The Illuminating Engineering Society is not, as a body, responsible for the opinions expressed by individual authors or speakers.

Standardization in Illuminating Engineering

(Proceedings at the meeting of the Illuminating Engineering Society, held at the House of the Royal Society of Arts, 18, John Street, Adelphi, London, W.C. at 7 p.m. on Thursday, February 25th, 1926.

A MEETING of the Illuminating Engineering Society was held at the House of the Royal Society of Arts, (18, John Street, Adelphi, London, W.C.), at 7 p.m. on Thursday, February 25th, Mr. C. C. PATERSON presiding.

The minutes of the last meeting having been taken as read the HON. SECRETARY read out the names of the following applicants for membership—

Members—

Cochrane, H. F.....Lighting Engineer, West Ham Corporation, 150, High Road, Leyton.

Payne, C. T.....Electrical Engineer, 3, Marsden Road, Tottenham, London, N.15.

Associates—

Tizzard, G. V.....Asst. Sales Engineer and Student, 583, Alexandra Park Road, Wood Green, London, N.22.

The names of applicants presented at the last meeting were read out again, and these gentlemen were declared members of the Society.*

The CHAIRMAN then explained that the meeting was to be devoted to a summary of the work of the B.E.S.A. in regard to standardization in illuminating engineering.

Mr. P. GOOD would present a summary of the aims and objects of the British Engineering Standards Association, explaining the steps that had led to the formation of the various committees concerned with illumination. Subsequently a discussion on the specifications that had so far appeared would be opened by the Chairmen of the respective committees responsible for them.

He accordingly called upon Mr. GOOD to read the opening paper, which was as follows:—

The British Engineering Standards Association Its Aims and Objects

By P. GOOD

The B.E.S.A. is an entirely independent body. It exists for the benefit of British industry, for the purpose of drawing up British Standard Specifications for materials, machinery and apparatus for the engineering and allied industries, its object being through simplification and standardization to eliminate national waste, to facilitate production, to simplify tendering, and to help British industry to meet competition in the world's markets.

It cannot, however, be too widely known that it does not embark on work on its own initiative, *but only on demands from outside*, and it acts generally at the specific request of an authoritative body, such as a representative trade organization, a technical society or a Government department.

From its inception, certain definite principles have governed its work, amongst which may be placed in the forefront the community of interest of producer and consumer, who are brought into consultation at the very commencement of any work, this, in fact, being the corner-stone of the movement. The B.E.S.A. is, in effect, a National organization in the closest touch with industrial requirements and modern technical knowledge. It has no Government control, its only authority being public opinion in the engineering and allied industries.

The sole authority is vested in the Main Committee, consisting of 30 members, 21 of whom are nominated by the leading technical institutions, five are co-opted by the nominated members, and three are ex-officio. The Committee acts under the constitution of the Association, in which rotation of office of the members is provided for.

The main object of industrial standardization is the saving of the waste of time and material involved in the production of a variety of sizes and qualities for one and the same purpose, thus contributing in large measure to the elimination of national waste. This object is best attained by a process of simplifying and unifying the needs of industry by agreement amongst the producers and consumers.

The B.E.S.A. Specifications are intended to include the technical provisions necessary for the supply of the particular material or apparatus concerned, but do not purport to include all the necessary provisions of a contract. They are of various types, sometimes specifying dimension only, when interchangeability alone is required, sometimes specifying quality of material as well as dimensions, and at other times specifying solely standards of performance to give an equitable basis of comparison.

To keep abreast of invention and progress and to prevent crystallization, the specifications are reviewed periodically, and any improvements or modifications which experience has shown to be desirable are duly incorporated in a revised edition.

SECTIONAL COMMITTEE ON ILLUMINATION.

In accordance with its usual practice, when the British National Committee of the International Illumination Commission decided to invite the B.E.S.A. to carry out the work of standardization in the field of illuminating, the Main Committee called a conference of all the interested parties. This conference was held in January, 1924, and representatives of the following bodies were present: National Illumination Committee of Great Britain, Ministry of Transport, War Office, Office of Works, Home Office, Department of Scientific and Industrial Research, Automobile Association and Motor Union, Royal Automobile Club, British Electrical and Allied Manufacturers' Association, British

*Illum. Eng. February 1926, p. 37.

Flint Glass Manufacturers' Association, Electric Lamp Manufacturers' Association, Society of British Gas Industries, and Society of Motor Manufacturers and Traders.

The Main Committee accepted the recommendation of this Conference, and set up a Sectional Committee, nominating Lieut.-Colonel K. Edgcumbe as chairman; the members of the National Illumination Committee of Great Britain were appointed members of the Sectional Committee, and those trade associations who had been invited to the Conference, the Government Departments, the A.A., and the R.A.C., were also asked to appoint members in order that all interests concerned might be represented. This follows practically the same lines as has been followed with the International Electrotechnical Commission, the Sectional Electrical Committee of the B.E.S.A. being, in fact, the British National Committee of the I.E.C.

The Sectional Illumination Committee of the B.E.S.A. concerns itself, of course, with any questions of standardization within the field of illuminating engineering, and does not confine itself to those points which are ripe for international consideration.

The Sectional Illumination Committee of the B.E.S.A. is of a thoroughly representative character, and it also benefits from the fact that many of its members are also members of other committees concerned with various aspects of illumination. Co-ordination of work and avoidance of overlapping of investigations are thus assured.

Specifications for portable photometers and for industrial reflector fittings for electric lighting and a glossary of terms used in illuminating engineering have already been issued by the committees respectively concerned with these subjects. Contributions outlining the work of these three committees are to be presented by their respective chairmen at the meeting. Three other committees already in existence and conducting useful investigations may be mentioned, namely, those concerned with Illuminating Glassware (Chairman, Mr. J. W. T. Walsh), Street Lighting (Chairman, Mr. C. C. Paterson), and Photometric Integrators (Chairman, Mr. J. W. T. Walsh).

Representative Character of B.E.S.A. Committees.

It cannot be too thoroughly understood that the B.E.S.A. Committees exist for the benefit of British industry, the character of their work is industrial, and they are not under the control of any one branch of industry—neither the purchasers, nor the manufacturers, nor the scientific men can be said to dominate the work. General agreement must be reached between all the interests principally concerned before the Main Committee will authorize the issue of a specification, and it is not, therefore, to be wondered at that B.E.S.A. specifications are looked upon throughout the world as authoritative documents. Their value to the public is, of course, great, and their value to British industry in connection with its export trade is also very considerable.

It would not be right to refer to the work of the B.E.S.A. without paying the highest tribute to those 2,000 engineers and business men throughout the country who give their time and experience to this work without fee or recompense, and often at great personal inconvenience, and in addition to the very valuable assistance rendered by the Department of Scientific and Industrial Research. Without the assistance of this Department in carrying out investigations, many of our specifications could not have been produced, and the value of the work done by the N.P.L. and by the Research Laboratory of the General Electric Company and the Lighting Service Bureau of the E.L.M.A. in connection with the preparation of the illumination specifications already issued and those in course of preparation can hardly be overestimated.

The B.E.S.A. is fully alive to the difficulties of the country's export trade, and through its Local Standards Committee abroad is keeping in close touch with the requirements of foreign markets, and the work of these committees is bound to prove of increasing utility to British export trade. The committees, therefore, deserve the cordial support of British firms, especially of those with agents in foreign countries.

An important development during 1925 has been the widening of the basis of membership of the B.E.S.A. whereby those associating themselves with the work will be kept in close touch with its progress and with standardization and simplification in other parts of the world. Members of the committees of the B.E.S.A. will in future be known as honorary members, and ordinary membership will be available to all connected with the industry on payment of a small annual fee. In return for this, members will be in a position to secure direct representation of their interests on the main Executive Committee through a duly elected Advisory Council, certain free copies of specifications and free advice on all matters of standardization, whilst they will have the additional satisfaction of knowing that they are assisting in a work of national importance.

The paper by Lt.-Col. Kenelm Edgcumbe, on "The B.E.S.A. Specification for Portable Photometers," was as follows:—

The British Standards Specification for Portable Photometers (No. 230/25)*

By Lt.-Col. KENELM EDGCUMBE

Committee: Lt.-Col. K. Edgcumbe (*Chairman*); W. E. Bush (E.L.M.A. Lighting Service Bureau); A. Cunnington (Railway Companies of Great Britain); J. G. Clark (Institution of Gas Engineers); G. Campbell (B.E.A.M.A.); I. S. Dow (Illuminating Engineering Society); Haydn T. Harrison (Institution of Electrical Engineers); W. J. Jones (E.L.M.A. Lighting Service Bureau); Professor J. T. MacGregor Morris (Institution of Electrical Engineers); C. W. Sully (E.L.M.A.); E. Stroud; J. F. Simmance; E. F. Stewart (Institution of Public Lighting Engineers); A. K. Taylor (National Physical Laboratory); J. W. T. Walsh (National Physical Laboratory). *Since added*: F. P. Driver (E.L.M.A.) and F. J. Hawkins (E.L.M.A.).

In drawing up this specification, two difficulties had to be faced. Entirely new ground was being opened up, since, so far as it could be discovered, no standard specification was in existence, and, moreover, photometers in general, and portable photometers in particular, had not so far developed along any generally accepted lines. In the words of the specification: "Photometry, even under laboratory conditions, is one of the less precise of physical measurements, and in the case of portable photometers liability to error is increased by the fact that many of the essential components of such instruments are susceptible to variation with time and use." Such being the case, the Committee had to decide whether to deal with portable photometers in general, or to narrow down the scope of the specification so as to cover those of the more utilitarian pattern only. The latter course was decided upon as being the most likely to fill immediate wants.

Such photometers fall broadly into two classes—those for exterior use (e.g., for street lighting) and those for interior use, such as for factories, shop windows, and commercial work generally (Clause 1).

The ranges for each class were fixed as follows: For exterior use, from 0·01 up to 2 (or preferably up to 5) foot-candles; and for interior use, from 0·2 up to 20 foot-candles, or preferably higher (Clause 2). Clearly, a photometer scaled from ·01 to 30 foot-candles, for example, is quite a practical proposition, and such an instrument would fulfil the requirements of both classes.

Measurements of illumination are undoubtedly the most commonly required, so that the majority of portable photometers are designed for that purpose. On the other hand, measurements of brightness (or "intrinsic brilliancy," as it used to be called) are often wanted, and for this purpose the surface whose brightness is to be measured is viewed through the photometer. It must be remembered that the brightness of the surface cannot,

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in that case, be read off the foot-candle scale of the photometer, since the standard surface with which the instrument was calibrated cannot reflect all the light it receives, so that its *brightness*, expressed in foot-candles, is always less than the *illumination* to which it is submitted. For this reason, the reading on the photometer scale must be multiplied by a constant, usually of the order of ·8, to convert the illumination into brightness. To avoid ambiguity, brightness is preferably expressed in candles per square foot or per square inch, rather than in foot-candles, which is a unit of illumination (Clause 5). The converted foot-candle reading divided by π gives the brightness in candles per square foot.

In Clause 5, the test surface (i.e., the surface which is exposed to the illumination under test) is dealt with. It has to be such that "its brightness is as nearly as possible proportional to the illumination, up to a large angle of incidence," and it is further recommended that the test surface should be viewed at an angle of about 30° with the normal, which was found by experiment to be the angle showing the smallest variation of brightness for a given illumination when the angle of incidence of the light was changed.

The variation of brightness for a given illumination with the angle of incidence is a matter of importance, particularly if direct measurements of horizontal illumination in outdoor installations are to be made. It is often said that no surface truly follows the cosine law, but this is a somewhat ambiguous way of expressing two facts, namely, that the illumination at a surface due to a given source, at a given distance, is proportional to the cosine of the angle made by the rays of light from that source with the normal to the surface, and further, that as the angle of incidence is varied, the ratio, brightness/illumination, will not usually remain constant, as it would in the case of a "perfectly diffusing" surface. Up to an angle of incidence of 75° or 80°, however, the error can be made small, if the surface is well chosen (Clause 10).

One of the provisions of Clause 5 may cause some surprise. It is specified that "for the purpose of testing the photometer, the angle of view shall lie in the plane of the incident light, and on the opposite side of the normal to the surface." It might be thought that in order to avoid disturbance by specular reflection from the test surface, it would have been preferable to view that surface in a direction normal, or nearly so, to the plane of the reflected ray. Careful tests by Mr. A. K. Taylor, of the N.P.L., however, proved that such was not the case, and, in fact, that by far the most consistent results were obtained when the incident and reflected rays and the observer's line of sight were all in the same plane. Hence the requirement in question.

It is laid down that the test surface shall be reasonably durable and capable of being cleaned or renewed. For this purpose celluloid or pot-opal glass has proved very suitable. Experience shows that convenience and precision are much increased if the two surfaces whose illumination is to be compared in the photometer are of reasonable dimensions, and it is consequently stipulated that the solid angle subtended by the test surface at the observer's eye shall be not less than 4°, and, moreover, that the test surface can be placed at least 4 feet from the photometer and still fill the whole of the field of view. This latter provision enables the test surface to be placed on the ground, if so desired (Clause 6).

Under Clause 8 it is essential that the equipment should include an ammeter or a voltmeter, preferably of the moving-coil pattern, and in this connection it is of interest to note that the change of candle-power for a given percentage change of current is greater than that for the same percentage change of voltage, so that it is preferable to employ a voltmeter rather than an ammeter. This is contrary to the usually accepted idea, in accordance with which an ammeter is considered preferable, in that it eliminates errors due to contact, resistance, etc. Such errors are guarded against in the specification by the stipulation that all connections should be clamped or soldered, and moreover, that a pair of wires distinct from those carrying the lamp current should be run from the lampholder to the voltmeter (Clause 8).

Difficulty is often experienced in using a portable photometer owing to the colour of the internal illuminated screen (comparison surface) differing greatly from that of the test surface. To minimize such difference, it is laid down that the comparison surface, when illuminated by its internal lamp, should have a colour similar to that of an ordinary metal-filament lamp, running at an efficiency of not less than 9 lumens per watt (say 1·4 watts per candle).

In fixing the permissible limits of error for a portable photometer, the various sources of inaccuracy must be considered in turn. Such errors are difficult to forecast, but might be tabulated somewhat as follows:—

	Per cent.
Gradual changes in the efficiency of the lamp ...	± 1
State of the test surface	± 5
Voltage Measurement (± 1¼ per cent.), say ...	± 6
Scale Calibration	± 4
Observer	± 4
	20

Whilst such errors might, of course, be all in the same direction, such a contingency is unlikely, so that an all-round accuracy of 15 per cent. seems a reasonable requirement (Clause 10).

At the same time, to express the accuracy as a percentage of the reading at all parts of the scale is unsatisfactory as regards its lower end, since the eye is less sensitive to small changes when the illumination is low. It is usually accepted that for a brightness exceeding ⅓rd foot-candle a difference of 1·5 per cent. can just be distinguished, whereas as at a brightness of 1/100 foot-candle a difference of 6 per cent. is required. Moreover, various sources of inaccuracy, such as scale errors, mechanical displacement of the parts, back-lash in the working parts, and so forth, represent a constant rather than a proportional error. In order to allow for this, the permissible error is expressed in the specification as 15 per cent. of the indication down to 0·1 foot-candle, and as 14 per cent. of the indication, plus ·001 foot-candle below this. This will be seen to give a permissible error of 15 per cent. at 0·1 foot-candle and of 24 per cent. at 0·01 foot-candle. This latter may seem to be a considerable error, but it should be remembered that it only represents an uncertainty of 1/400th foot-candle. The only case in which such low illuminations are likely to be of importance is in the direct measurement of horizontal illumination, in connection with street-lighting contracts, but it is recommended (Clause 10) that such tests should be carried out by measuring the direct illumination on a screen placed normal to the rays of light, since such measurements can be made with much greater precision, and, further, the horizontal illumination can be readily calculated.

The next item on the programme was the following paper by LT.-COMMANDER HAYDN T. HARRISON:—

The British Standard Specification for Industrial Reflector Fittings for Electric Lighting (No. 1)*

By Lt.-Commander HAYDN T. HARRISON

COMMITTEE: Lt.-Commander Haydn T. Harrison (*Chairman*); H. Booker (Government Interdepartmental Committee for Electrical Service); H. Buckley (National Physical Laboratory); J. Bridger (Society of British Gas Industries); W. E. Bush (E.L.M.A. Lighting Service Bureau); F. M. Cocksedge (B.E.A.M.A.); G. Campbell (B.E.A.M.A.); Lt.-Col. K. Edgcumbe (ex officio); R. Gunner; L. Gaster (Illuminating Engineering Society); L. B. W. Jolley; W. J. Jones (E.L.M.A. Lighting Service Bureau); H. H. Long (B.E.A.M.A.); A. C. Pallot (H. M. Office of Works); Randall (B.E.A.M.A.); P. Sugg (Society of British Gas Industries); C. A. Smith (B.E.A.M.A.); G. H. Spittle (Railway Companies of Great Britain Ltd.); C. W. Sully (E.L.M.A.); E. H. Walters (General Post Office); D. R. Wilson (Home Office). *Since added*: F. P. Driver (E.L.M.A.) and F. Hawkins (E.L.M.A.)

As Chairman of the Committee responsible for the above specification, I have been asked to say a few words with reference to same. I am pleased to have

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this opportunity of calling your attention to the large amount of valuable research work which has to be carried out before a specification of this nature can be issued, and to emphasize the fact that without the assistance of such institutions as the National Physical Laboratory it would be difficult to issue these specifications which are of great value to all concerned.

As I understand that the valuable data obtained by this work will be duly published by those who carried it out, I do not propose to place results before you now, but only to deal with the effect it had upon the drafting of this specification, which condenses into less than 200 lines not only the result of the information gained by their researches, but also the benefit of the experiences of representatives from the following Societies and Government Departments: The National Illuminated Committee of Great Britain, Illuminating Engineering Society, Institution of Gas Engineers, Institution of Electrical Engineers, Office of Works, General Post Office, Electric Lamp Manufacturers' Association, Society of British Gas Industries, National Physical Laboratory, and the British Electrical Allied Manufacturers' Association. Other representatives were from time to time co-opted to place before the Committee their experiences and advice.

The terms of reference, namely, " to consider whether the time is ripe for the standardization of Industrial Direct Lighting Fittings," when discussed, led to the unanimous decision that at least one type of such fittings, namely, those used for factory lighting, should be standardized as soon as possible in order to assist the excellent work carried out by the Home Office in preventing eye-strain in factories or the like.

Investigation proved that the general form of lighting fitting which had been found most suitable for this purpose was that known as the " R.L.M. " type, and that this had been largely adopted both in this country and America.

This type of reflector fitting is too well known to need description here; its three main features are:

(a) That the source of light (or lamp filament) can be made invisible above a definite angle of cut-off.

(b) At the angle where the filament is visible it is viewed against a highly illuminated white reflecting surface.

(c) This reflecting surface, being vitreous enamel and accessible, is easily cleaned.

The use of such reflectors, if correctly and strongly constructed, placed at suitable heights and distances, when fitted with the lamps for which they are designed, and kept clean, will provide and maintain the degree of illumination required for most factory work without causing eye-strain or the unpleasant effects of glare. But it will be noted the desired result depends on several details which no specification relating to the reflectors only can control, the most important of these being to ensure that they are fitted with the lamps for which they are designed.

Such lamps are, therefore, scheduled on the first page, which is extracted from B.E.S.A. Specification No. 161—1924, but a footnote calls attention to the fact that the light-centre length tolerances allowed in that specification do not apply in connection with the tests referred to in Clauses 4, 5 and 6; in other words, the test results may not recur in practice due to tolerances contained in another specification.

Unfortunately, illuminating results depend on several factors which may appear insignificant, but which do in fact affect the result considerably. For example, in this specification the words " appropriate lamp " often occur, a general term which is open to criticism. But it will also be noticed that no tolerances are mentioned, and that for the purpose of testing it is definitely stated that the light-centre length shall be as given in Columns 5 and 6 of the table.

If this table is compared with the lamp specification from which it is extracted it will be noted that a tolerance of 10 per cent. *plus* or *minus*, with a maximum of 10 millimetres, is allowed to the manufacturers of the lamps. Thus a reflector designed for a 70° cut-off (20° from the horizontal) might in practice have a cut-off varying from 18° to 22° in the large sizes, or 18° to 24° in the small sizes; therefore it is necessary that some word qualifying the lamp must be used.

The question of angle of cut-off is one which received much attention from the Committee. It was fully realized that the recommendations of the Departmental (Home Office) Committee on Lighting in Factories and Workshops had been agreed upon after most careful investigation. Therefore it was agreed that the " angle between the line from the eye to an unshaded part of a source and a horizontal plane " should not be less than 20°, and this figure was adopted in Clause 6 of the specification. Nevertheless it was also borne in mind that the practice in America was to define this angle at 17½°; but in face of the tolerances already referred to it was not considered wise to specify less than 70° from the vertical.

Probably many of those present would hold the view that tolerances in lamp production should be corrected by means of adjusting appliances in the reflector fittings. This would no doubt be a satisfactory solution if there was evidence to prove that such adjustments were made by the class of labour generally employed to replace or clean lamps. But no such evidence was forthcoming, and it was, therefore, considered wiser to allow for discrepancies which we know exist rather than incur the risk of greater discrepancies which would occur if adjustments were made in the wrong direction.

Another figure in the specification which may surprise and disappoint many is that the efficiency demanded should be as low as 60 per cent., especially as vitreous enamelled steel is generally considered to have a high reflecting value.

The tests of the National Physical Laboratory on which the figure of 60 per cent. is based emphasized the fact that the efficiency is rapidly reduced as the angle of cut-off is increased. For example, if this angle be 17½° below the horizontal, as adopted in America, there is no difficulty in obtaining an efficiency of 70 per cent., whereas with 20° cut-off 60 per cent. is all which can be expected. A simple calculation in solid angles will demonstrate the reason for this.

If the rays from the light source be truly spherical, and are allowed to shine directly over a solid angle of 145°, 35 per cent. reach the area to be illuminated without interruption. But if 140° is adopted only 30 per cent. of the rays are directly utilized. Thus 65 and 70 per cent. of the luminous energy reaches the reflecting surface respectively, and of this, in the case of 140°, 30 per cent. of the original total is obtained. Thus the reflecting surface proves to have an efficiency of 43 per cent. Consequently if the position of the light source is moved so as to increase the relation of the reflected rays to direct rays, with a reflector of so low a reflecting value the loss in total efficiency must necessarily be great.

The distribution of light is dealt with in Clause 5 by a method which simplifies testing, but the note attached to this clause which limits spacing must be borne in mind, as these reflectors are not intended for wide spacing.

The reflecting value of vitreous enamelled ware has been found by the writer to depend largely upon the angles of incidence and reflection; it is, therefore, not the most suitable surface for all purposes, but is much favoured, due to its permanence and the ease with which it is kept clean.

The principle of cutting off the direct rays from the field of vision is one which at the present time appears to be most satisfactory, but illuminating engineering being a progressive science, there is every reason to believe that improvements will be made both in the efficiency of the fittings and the general arrangement of same, in which case the specification would be modified from time to time in order to take advantage of such improvements.

In the opinion of the writer, it is most important that no obstacles should be put in the way of progress, but it is equally, if not more, important that the eyesight of the nation should be preserved, which will be the case if this specification is closely adhered to by the manufacturers and users. Thus it cannot fail to fulfil the useful purpose for which it is intended.

Mr. P. GOOD then gave his address on the Glossary, which was as follows:—

The British Standard Glossary of Terms used in Illumination and Photometry

By P. GOOD

COMMITTEE: Lt.-Col. K. Edgcumbe (*Chairman*); P. Good, Dr. A. Russell, and J. W. T. Walsh.

THERE is very little difficulty in satisfying an enquirer as to the usefulness of many of the B.E.S.A. specifications, but sometimes difficulty is experienced in making clear the benefits which accrue from the work on Nomenclature and its allied subject, Symbols. On the other hand, to those who are not completely immersed in the struggle for existence and who can devote a little time to looking around to see what is really important in the world, this work appeals strongly. It has frequently been asserted that the basis of civilization is Transportation, but looking deeper one ventures to think that the basis of civilization is really "Communication."

In illumination matters, the mechanism for communicating freely exists both nationally and internationally—nationally through the agency of this Society, the British National Illumination Committee, and through the B.E.S.A., and internationally through the International Illumination Commission, but there is still of course the stumbling block of language. Unfortunately the most advanced people in the world, the scientist-engineers, seem ready to build up new towers of Babel with every advance in knowledge—they allow the slang of the laboratory and workshop to make their speech almost unintelligible.

The significance of words, the amazingly important part they play in human affairs, and the desirability of their accurate use, are perhaps even now only admitted by the few. The enormous debt we owe to the translators of the King James' Version of the Bible and to Shakespeare is perhaps not generally recognized, and although some changes in nomenclature have been made since then and a "standing still" policy is not very useful, yet the stability which these writings have given to the English language is enormously to the good, helping the greater number to understand and learn by the recorded experiences of the past as well as to gain much benefit from the beauty and simplicity of the language of our forefathers.

I am not proposing a direct comparison between the Glossary of Illumination Terms and either of the mighty works I have referred to: but I do suggest that the importance of authoritative lists of terms and definitions such as I have the pleasure to present is very great. Every Illuminating Engineer should recognize that he has a duty to perform in maintaining the accurate use of words, when describing his work, so that the writings of to-day will be readily understandable by those who will carry on the work during the later years of this century.

It is common knowledge that the reader of a letter seldom gets out of it all the writer puts into it—unless the writer has gone to the trouble of disciplining himself to use his words correctly. In the writing of many novels, newspaper articles, etc., it possibly matters little either way. Quite frequently the writer has nothing worth while to say and the reader only reads because he has nothing better to do, but this sort of writing and reading is of no use for scientific purposes. Science, if it implies anything, implies exact knowledge, and the fundamentals of understandable writing are words the meaning of which can be exactly understood.

Scientific and technical language needs, of course, to grow with the growth of knowledge, but the necessity for stabilizing the language and for making efforts to secure that the meanings of terms are as far as possible retained permanently is urgent. This does not prevent growth; rather does it encourage cultured growth.

It is hardly necessary to recall the great benefit which must accrue as a result of agreement with our Amercian cousins on the use of English terms and the still greater benefits which will result from the knowledge of the correct foreign terms to use for the ideas expressed in these definitions. There is just one sad feature—you can perhaps picture the distress of those members of the committee who have a nice ear for sound when such words as Phot obtain acceptance!

We owe a considerable debt to those who have devoted very much time and thought to the preparation of the list of terms which I have been asked to present to you in the unavoidable absence of Mr. Walsh who, with Colonel Edgcumbe, Dr. Russell and Professor Morris, has given much time to this work.

In endeavouring to define the fundamental terms used in illumination work, the Committee was faced with some difficulties, and the discussion occasionally ventured into the metaphysical. Some desired that we should base the fundamentals on the work done by the luminous energy measured in mechanical units, and thus build up a proper and complete new system of units and terms. The results, compromise perhaps in some cases, are shown in B.E.S.A. Publication No. 233.

The list before you is not complete, and the first thing that must be asked is that, whilst criticism is desired, it must not be supposed that a very scientific or literary defence will always be forthcoming. This list represents agreement reached after thorough discussion both here and abroad, and mutual concessions are necessary. Current practice cannot be set aside. Words in common use have a vested interest, and in many cases must be retained.

The first term and definition (Luminous Flux) is fundamental. As an interesting historical fact and as illustrating the spirit of compromise, as well as some of the difficulties which are involved in work of this nature, the following extract from a report submitted by the British Committee to the International Illumination Commission meeting in Geneva (1923) may be quoted. After explaining why they proposed the use of "luminous radiation" and "luminous source," both of which terms have since gone out of the list, the Committee said: "It will be remarked at once that the word 'flux' is generally employed in the English language to denote a flow and not a rate. The word 'radiation' conveys the same idea. It, therefore, seems reasonable to regard 'luminous flux' as synonymous with 'luminous radiation.' Since, however, 'flux' has been so frequently employed and defined as a rate involving the notion of time, it appeared to the Committee advisable to avoid the word 'flux' altogether and to use the term 'luminous radiation' alone. The other countries did not agree, and we have accepted 'luminous flux,' and it is the first term defined, and we are now loyally adopting it."

The British list of terms does not include a definition of the term light, although the American Glossary starts with it. Personally I find it a little difficult to be pleased with one of their definitions of light, viz., "radiant flux of wavelengths outside the visible spectrum." Unfortunately it is used in this sense in this country in such terms as ultra-violet light and invisible light, but I do not like to think that such a statement as "my aerial is exposed to the light emitted by 2 LO" is correct, and I hope some better definition will be evolved which limits the use of the word "light" to a definite position on the electromagnetic spectrum.

The British List omits all reference to terms used in regard to luminous flux from the point of view of energy—(ergs per second or watts), whereas the Americans use the term 'radiant flux' for this purpose.

There are still many terms to be defined, and suggestions as to them would be useful to the Committee.

Discussion

Mr. H. BUCKLEY did not quite agree with Mr. Harrison in attributing so low a coefficient of reflection to enamelled iron. Its valuable properties to illuminating engineers had been somewhat underated. Mr. Harrison's reasoning appeared to assume that an incandescent lamp emitted as much light in the upper hemisphere as in the lower one, moreover whilst the specification mentioned 20° as the angle of cut-off that referred to the circumference of the filament and not its centre, so that the actual angle was more like 22°. From his experience it appeared that the highest efficiency realized under average conditions was about 55 per cent. As the filament was raised the efficiency seemed to get less, and as it was lowered there was a greater likelihood of multiple reflections. But he thought that if tests were made with the filament in the most favourable position an efficiency of 60 per cent. might be obtained, and possibly more.

Mr. G. CAMPBELL expressed his great appreciation of the introductory paper read by Mr. Harrison, which explained in concise terms the problem with which this committee had to deal. As one of the representatives of the B.E.A.M.A. on the committee he wished to express his recognition of the patient manner in which Mr. Harrison had guided its investigations. To him (Mr. Campbell), as a manufacturer and as one who had been associated with the introduction of the original R.L.M. type of reflector, the adoption of the specification was a welcome step. It furnished a proper indication as to what was meant by "efficiency" and should serve to discriminate between reflector fittings of scientific design and those of inferior types, to which high sounding titles were sometimes applied. In particular the absence of a clear definition of the functions of a reflector had encouraged claims for excessive efficiency, with subsequent disappointments. He therefore welcomed the idea of standardizing lighting fittings of approved design as likely to be of service both to the public and the lighting industry.

Mr. Harrison had referred to one point that had been a source of some difficulty in drawing up the specification for reflectors,—the effect of the tolerances allowed to the dimensions of lamps and positions of filaments in the B.E.S.A. Lamp Specification. Variations in this respect had for long proved a source of trouble to makers of reflectors, as the whole effect and the nature of the distribution of light depended on the position of the filament within the reflector. Illuminating engineers were also placed in the position that they could not be certain that the anticipated results would be obtained with a certain reflector in practice, owing to possible variations in the lamps used. The existing Lamp Specification had effected some improvement, but in view of the exceedingly important bearing of this point on practical lighting problems it was most desirable that the degree of variation of positions of lamp-filaments within the bulb should be confined within smaller limits. He (Mr. Campbell) fully realized the difficulties which standardization in this respect might impose on lamp-makers, but he believed that once agreement was reached the results would be beneficial to everyone. Lamp manufacturers kept within the limits of the specification, but what was needed was an effort for all to adopt one common point for the light-centre of the filaments. It would, therefore, be reassuring to learn that members of the E.L.M.A. were making concerted and serious efforts to deal with this point.

As Mr. Harrison had explained the selection of 20° for the cut-off angle was due mainly to the desire to comply with the recommendations of the Home Office Departmental Committee on Lighting in Factories and Workshops. But it should be realized that the more the filament was screened the greater the diminution in efficiency. He believed he was correct in stating that none of the American regulations contemplated an angle of cut-off greater than 14°, and whilst he was in full accord with the desire to minimize glare, it was evident that the adoption of the higher angle rather tended to impose a limit on British manufacturers. On the other hand he wished to make it clear that there was no need for alarm at the figure suggested for the realizable efficiency—about 60 per cent. There were many fittings in use which did not approach this efficiency, and yet had none of the advantages associated with the R.L.M. type; hence the general adoption of reflectors designed in accordance with the specification would lead to a great advance in the prevailing efficiency of lighting installations without any additional expenditure on electricity being involved.

In conclusion Mr. Campbell pointed out that this figure should be regarded as a *minimum*, and not a *maximum*, and that there were still possibilities of advances in design. In illustration of this he referred to a new form of fitting exhibited at the meeting, which showed a marked improvement in efficiency as compared with the R.L.M., and at the same time lent itself completely to conformation with the requirement of eliminating glare.

Mr. R. A. IVES also referred to possibilities of progress in industrial reflectors. Mr. Harrison had indicated the possibility of such improvements, and no doubt the specification might require modification from time to time in accordance with further developments. As an illustration of new methods Mr. Ives exhibited the Biflector type of fitting, having a special ring of opaque or translucent material which served to screen the filament completely. This design enabled an angle of cut-off of approximately 25° to be obtained conducive with an extensive distribution of light and a high efficiency.*

Lieut.-Colonel C. H. SILVESTER EVANS said that realizing the immense amount of work voluntarily subscribed by the various members of committees of the B.E.S.A. he hesitated to raise—in the smallest measure—the voice of criticism. Mr. Good had furnished two most interesting summaries. If the work of the Committee on the Terms Used in Illumination and Photometry was to have its fullest effect, everyone connected with the subject must ensure that the Terms are rigidly observed. Assistants in laboratories and those writing on this subject should have B.E.S.A. Publication No. 223 before them always, until such a time as it became second nature to employ the correct terms laid down.

Mr. Good had rightly drawn attention to the prevalent laxity in technical descriptive matter by those of our profession. He recollected the case of a piece of small apparatus which someone once carried, whereupon it was immediately termed "portable apparatus"; when it increased in size and was somewhat bulky to carry, it was termed "transportable apparatus"; shortly afterwards it was again enlarged, and could not be carried by hand, when it became "semi-transportable apparatus." The various forms of the apparatus were all essentially the same, but the terms of description conveyed no sense, except to the inner circle who knew its development.

Regarding Colonel Edgcumbe's remarks, he must admit that he was startled at first at the large margin of error permissible in portable photometers, but on consideration realized that it was a reasonable allowance.

He considered that a great concession is made in paragraph 9 (a) of B.E.S.A. Publication No. 230, in permitting lamp connections to be clamped; though ready change is not effected with soldered connections, much trouble has always been experienced in any other form of connection: similar remarks applies to any form of lamp-to-lampholder connection other than soldering. He sincerely hoped that manufacturers will avoid any but soldered connections throughout the instruments.

Mr. H. C. ALLPRESS said that the new specification for portable photometers should meet with general appreciation, and the committee were to be congratulated on the successful carrying out of a difficult task. Obviously progress in illuminating engineering depended largely on the accuracy and convenience of portable photometers available, and their widespread use. Within the last few years a number of different types had been introduced, mainly simplified instru-

* This form of fitting was illustrated and described in *The Illuminating Engineer* for December, 1925, p. 336, together with other recent types. See also p. 84 in this issue.

ments intended as rough indicators of illumination and aids to salesmen. The time was ripe for a specification marking a clear line of division between instruments of this type and those intended for more accurate work.

A photometer complying in all respects with the Specification would be a very useful instrument, but he was inclined to think that the recommendations in regard to accuracy were lenient. Even so the accuracy demanded was higher than that attainable from some forms of instruments in use, but serious investigators should not regard the figures mentioned as the limit of possible accuracy. This applied particularly to values read at the lower end of the scale; it was quite possible to design an instrument free from backlash. The specification would doubtless require periodical revision and it was only natural that further progress would lead to a stiffening up of requirements.

The inclusion of the introduction indicating the various sources of error was a useful step, but he hoped that this would not make users apprehensive. Frequent overhauling of an apparatus was judicious. Yet a photometer of suitable design should, if not subjected to abnormal usage, be no more untrustworthy or liable to sudden variation than the voltmeter which formed part of its equipment. He was glad to note that the electrical side of the instrument had been fully considered. In the case of circuits operating on low voltage and comparatively high current, absolute freedom from intermittent variations in resistance was essential. He himself had found that a high-resistance voltmeter connected independently across the lamp terminals formed one of the best possible indicators of varying contacts.

The wording of the specification seemed to allow some form of press-switch, presumably pressed at the moment of taking readings to be embodied. He was inclined to suggest that a switch of this type was best omitted. It should be understood that some form of variable resistance should be included in the circuit so that the lamp could be rated for a voltage somewhat under the normal voltage of the battery. The resistance could then be adjusted until the lamp received the correct voltage. If the lamp was left alight for a few moments it would sometimes be found that the voltage across it had diminished slightly so that readjustment of the resistance was necessary. When once the voltage had settled down a series of readings could be taken without any fear of further variation. But even quite large accumulators which had been partially discharged required a few moments to settle down after switching on, and would recuperate again when switched off.

He was glad to see that a provision for measuring the angle of incidence of the light and the inclination of the test surface was included. To meet this requirement a test surface had been designed which enabled such angles to be determined readily with reference to one angular scale only. This device was now incorporated in the standard equipment of the Holophane Lumeter.*

Mr. T. E. RITCHIE considered that the B.E.S.A. were to be congratulated on the specification dealing with reflectors for industrial use. He believed that time would show that of all the good things they had done this was one of the best. The influence of such a specification would be far-reaching, and it would afford to the lighting industry a protection which was badly needed. Those engaged in the production of fittings for industrial lighting would have to set to work to produce something which completely satisfied the requirements of the specification. The conclusion which appeared to be drawn by Mr. Harrison's remarks was that the efficiency derived from reflectors complying with the specification would be only 60 per cent. He thought that what was really conveyed was that the efficiency might exceed 60 per cent., but should not be less. He believed that in future it might be found possible to effect considerable improvements.

Having selected a suitable reflector it was most important that it should be kept clean and he hoped that more attention would be paid to this matter than in the past. Some forms of lighting units could only be kept clean with considerable difficulty; yet the diminution in efficiency resulting from want of cleanliness might be very great. With regard to the angle of cut-off he thought it quite possible that ultimately a measure of protection exceeding that stated in the specification might be found necessary.

Mr. A. CUNNINGTON remarked that the Specification has conferred a status on the portable photometer. Its advantages were not yet sufficiently realized, and he remembered hearing a public lighting inspector refer to it in terms of dislike and even contempt. He hoped that every effort would be made to make the work of the B.E.S.A. familiar and emphasized the fact that the portable photometer was no longer to be regarded as a sort of scientific toy.

Capt. W. J. A. LIBERTY also expressed the hope that technical journals would give the widest publicity to the work that was being done under the B.E.S.A., and hoped that one result of the meeting would be to make it widely known.

Mr. L. G. APPLEBEE referred to the importance of standardizing the positions of filaments in bulbs, and also the dimensions of the bulbs. He was glad to hear that there was a prospect of further progress in this direction.

Mr. JOHN DARCH commented on the Glossary of Terms used in Illuminating Engineering. He recalled that he himself, finding the need for a list of definitions some thirteen years ago, had prepared one which was published by the Society of Architects. He believed that these would not require any material alteration to-day, and would like to hand this over to the Hon. Secretary for consideration.

Mr. D. H. OGLEY suggested that some of the requirements in the Specification required further elucidation. For instance it was stated that three coats of enamel were required for the reflectors, but the quality of enamel was not specified. Manufacturers were apt to evolve their own standards and this led to confusion. The convenience of securing uniformity would amply compensate for individual sacrifice. In regard to the screening of filaments from the eyes it must be remembered that workers preferred "cheerful" lighting, and it was necessary to avoid conditions which were liable to have a depressing effect.

Mr. C. A. SMITH agreed that some installations in which enamelled reflectors were used were apt to be depressing. In the case of female labour it was specially important to avoid such conditions. There were now available forms of reflectors which he thought would meet requirements in this respect. Whilst the Specification on reflectors referred primarily to industrial work, he would like to draw attention to another most important problem—the lighting of schools. It was vital that young people should be safeguarded against eyestrain and he hoped that the provision of proper lighting units for schools would likewise receive attention.

Lt.-Colonel KENELM EDGECUMBE, replying to the discussion, remarked that attention had been concentrated largely on the recommended limits of accuracy. The committee had considered this point very carefully, and he thought that the values assigned were about right. Mr. Trotter, in a written communication, had suggested that in testing a photometer one should get in line with the light-source, but not in using it. This, however, was not in accord with the experience of the committee. Mr. Taylor's investigations had shown that the effect of alterations in the angle of incidence of the light were very much less if the screen was in line with the light. In these circumstances the inaccuracy, for angles not greater than 70°, could be confined to less than two per cent.

Lt.-Commander HAYDN T. HARRISON expressed his interest in Mr. Buckley's remarks, and pointed out that the difference involved was merely dependent on the point of view taken. He agreed with other speakers that the 60 per cent efficiency was to be regarded as a minimum, and he did not suggest that it was impossible to obtain higher values.

* An account of this apparatus, which was exhibited at the meeting, will be found on p. 84.

Mr. P. GOOD remarked that the actual work of drawing up the specification had been done by the members of the B.E.S.A. committees, some of whom were present. He suggested that the congratulatory remarks of the audience should be conveyed to them when they next met. Some useful constructive criticism of the specifications had been made, and this showed that a good purpose had been served by the meeting. The committee would be only too pleased to receive suggestions of this character.

Mr. L. GASTER, in proposing a vote of thanks to the authors, also took the opportunity of thanking the B.E.S.A. for giving the Society the opportunity of hearing an account of the excellent work that was being done. He hoped that one result of the meeting would be to give further publicity to this splendid work, which deserved to be very widely known.

The CHAIRMAN (Mr. C. C. Paterson), in putting the vote to the meeting, also referred to the valuable work that the B.E.S.A. was doing for illumination. This work was only beginning. The reception of the specifications would encourage the study of other aspects of illumination, on which common agreement was desirable, so that illuminating engineering would stand out before the world as having a mind of its own, a policy of its own, and achievements of its own.

The vote of thanks having been carried with acclamation, the Chairman announced that the next meeting would be devoted to a discussion on Stage Lighting, after which the members took the opportunity of examining the various exhibits. (See pp. 84-5.)

Communicated Remarks

Mr. W. J. JONES: I think that the Society is to be congratulated in having the opportunity of discussing the B.E.S.A. Specifications which affect illumination, and it is gratifying to realize that within such a comparatively short time of their constitution it has been possible for the various committees of the B.E.S.A. to issue such interesting, and, I trust, useful specifications.

The general value of standardization has already been dealt with fully at the hands of more able people than myself, but from the point of view of the lamp manufacturers and suppliers of fittings, it will facilitate enormously the distribution of material and directly influence the standard of illumination in this country. It has truly been said that a house that is divided against itself cannot stand, and this is peculiarly true in matters of illumination. Where there have been such heterogeneous recommendations and types of equipment, it is small wonder that the user is mystified and that artificial light is not used efficiently. There is no need to dogmatize in every case, but there are many instances in which definite recommendations can be given. With reference to the specifications which are under discussion, I propose to make one or two comments on them individually.

Portable Photometers.—In these days when we are endeavouring to concentrate more on effective illumination rather than the amount of "raw" light emitted by the lamp, it is appropriate that some standard specification should be available on the portable photometer. Those intimately connected with this work are already conversant with the limitations of this form of instrument, but this Specification definitely prescribes the kind of efficiency which might be expected, and does much to limit the errors which have been possible in the past. It was found necessary to do more than merely specify the chief feature of the instrument, and to include a certain amount of information regarding its use. The issue of the Specification will do much to improve the standard and convenience of portable photometers.

Industrial Reflector Fittings.—Here again, in addition to dealing with the details of the reflector, its contour, etc., it was considered essential by the Committee to give some suggested method of measuring the efficiency of the equipment, and in some cases a few qualifying remarks have been found necessary in order that the British product shall not compare unfavourably with that in any other country. This is particularly noted in paragraph 4 when dealing with the question of luminous output.

In this case, due to the fact that reflectors were called upon to meet the recommendations contained in the second report of the Departmental Committee on the Lighting in Factories and Workshops, 1921, a rather lower figure of luminous output is permitted, namely 60 per cent., than was obtained under the conditions which were usual formerly, namely, 70 per cent.

It will be further noticed that these specifications are definitely designed to keep up with existing B.E.S.A. Specifications, and, in particular, that important work, B.E.S.A. No. 161, dealing with incandescent electric lamps. The responsibility of the members of the committee who drew up the Specification No. 161 becomes more onerous as time goes on, in view of the fact that many of the subsequent specifications on illumination will depend thereon.

Glossary of Terms in Illumination.—With regard to terms used in illumination photometry, it is now several years since this Committee first commenced its activities, and this Glossary should be of value to all who are engaged in illumination problems.

In one or two instances I am under the impression that there are terms which could usefully have been entirely omitted or even linked up satisfactorily with associated terms, while the term "visibility factor," in my opinion, is not without a dual meaning as it is usually employed. The term "visibility factor" itself is likely to be confused with the degree of visibility of an object, which may be dependent upon such factors as brightness, nature of background, local conditions, etc.

In the definition of "Diffused Lighting" no account is taken of diffused lighting which is obtained from an indirect lighting system, and, in my opinion, the definition itself requires revision.

Mr. G. J. WELLS: I am sure that the majority of lighting fitting manufacturers will welcome the B.E.S.A. Specification as applied to reflector fittings, and do all they can to secure the recommendations being universally adopted.

I am well aware of the good work of the Illuminating Engineering Society in this direction and the vast amount of propaganda work on these lines that various lighting fitting manufacturers have carried out for some considerable time.

Unfortunately, in the absence of such recommendations being embodied in an Act of Parliament, it is regrettable that, in many instances, only the cheapest of equipment is installed, the main consideration apparently being price.

I can only hope it will not be long before the worker is compulsorily protected, from the point of view of glare. In this respect, it seems to me that the Trade Union movement would do well to investigate the claims of good lighting and the undoubted harm to their members from bad lighting, and press for legislation that would afford the workers maximum eye comfort and, incidentally, enable them to increase production and minimize the risk of accidents.

Mr. F. W. THORPE: It appears to me that it would be useful if several alternative methods of meeting the recommendations of the Home Office Departmental Committee on Glare, apart from the employment of a specified steel reflector, could be given.

The conditions might, for example, be met by:—

(1) The use of the steel reflector with an angle of cut-off of 20° where a spacing of 1½ to 1 is possible.

(2) The use of a shallow steel reflector with filament almost level with the edge of the reflector, provided the lower half of the bulb of the lamp is enamelled. (This type of reflector is very popular, but is often used with bare filaments.)

(3) Reflectors with open bottom bowls, or alternatively with a ring shield of metal or diffusing glass.

(4) The use of an opal or diffusing lower bowl under the lamp, with a more extensive over-reflector.

Mr. Alexander Pelham Trotter

(*Past President of The Illuminating Engineering Society*).

MR. ALEXANDER PELHAM TROTTER, born at Woodford, Essex, on June 25th, 1857, comes of a Scottish border family on his father's side and of an Orkney clan on his mother's. He was educated at Harrow, where he won an open swimming race, and in the school diving prize of 1873 made a record swim under water. Entering Trinity College, Cambridge, in 1876, he read for the Natural Sciences Tripos, attending some of Clerk Maxwell's lectures. He took second class honours in the Tripos (notwithstanding the fact that he did not begin differential and integral calculus until a year or two after leaving Cambridge). Bicycling was then in a rapid stage of development. During a vacation he made a tour of 1,000 miles on the Continent, and was fined by the police at Basle (where no bicycles had been seen at the time) for being a dangerous nuisance. With a 58 in. machine built to fit him he broke the mile record on the racing track in 1878, and the two and four-mile records.

He articled himself as a pupil to Messrs. Easton & Anderson, of Erith (1880 to 1883), and during this period worked out and patented his invention of dioptric shades and lanterns, the first prismatic glassware, afterwards developed in 1892 by Blondel and Psaroudaki into the Holophane system. His invention, which was about 15 years before its time, was described in the Proceedings of the Institution of Civil Engineers in 1884, and in the same year was awarded a silver medal at the Health Exhibition. It brought him into touch with Mr. (afterwards Sir William H.) Preece, Engineer-in-Chief of the Post Office, who was making reports to the Commissioners of Sewers on electric lighting in the City. Mr. Trotter's pioneering work with Mr. Preece was described in *The Illuminating Engineer* (first series), Vol. 2, 1909, to which he contributed a classic series of articles on "Illumination: its Distribution and Measurement." This afterwards formed the title of his well-known book.

From 1884 to 1887 he went into partnership with Mr. Goolden, and managed their factory at Halifax. The dynamo makers in this country could at that time be counted on the fingers of one hand, and in competition with them Goolden and Trotter built the largest dynamos ordered by the Admiralty. Central stations being then unheard of, the chief business was in mill lighting and ship lighting. Five large vessels were equipped for the British and Indian Governments.

In 1887 Mr. Trotter returned to London and practised as a consulting engineer. He advised on the lighting of the Agricultural Hall and several theatres, developing his portable photometer for the work. In 1892 his paper on "The Distribution and Measurement of Illumination" received the unusual distinction of the Telford Medal and the Telford Premium of the Institution of Civil Engineers. Many papers were contributed to the Physical Society, the Institution of Electrical Engineers, the British Association, and other bodies. In 1894 he read before the Royal Society a paper on "The Rotation of the Electric Arc," describing a phenomenon which has not been completely explained to this day.

From 1890 to 1895 he was editor of *The Electrician*, with the assistance of Mr. W. G. Bond. Fleming, Ewing, Heaviside, Kelvin, Ayrton and Kapp were amongst his contributors, and many of their pioneer works appeared in his columns as serials. In 1889 he was appointed technical secretary of the Electrical Trades Section of the London Chamber of Commerce. In 1895 he was appointed Government Electrician for the Cape of Good Hope, and had to administer an Electric Lighting Act modelled on Board of Trade lines. The electric tramways of Cape Town and district interfered seriously with the working of the submarine cables. The problem was studied by Mr. Trotter, and a paper written on this subject by him, sent home to the Institution of Electrical Engineers, was awarded an extra premium.

After three and a half years he was appointed Electrical Adviser to the Board of Trade, and held that position for 18 years. Whilst in Government service he dropped all his patents. He had to inspect every new electric tramway in the United Kingdom and to report on it to the Board of Trade before approval was given. Long after the Railway Department of the Board of Trade had sanctioned the use of trolley wires, the Harbour and Fisheries Department, which was concerned with electric lighting, refused to permit overhead wires. When sanction was at last obtained, Mr. Trotter had to advise on the necessary regulations, and was permitted to read a paper on the subject before the Institution of Civil Engineers in 1907.

Mr. A. P. Trotter
(As a Private in the National Guard, 1917.)

A Telford Premium was awarded for this paper. In the Board of Trade Electrical Standards Laboratory (now absorbed in the National Physical Laboratory) he had charge of the standard ohm, the standard ampere balance, and many sub-standards. The precision thus acquired was turned to good account during the war, when many steel gauges were made in the laboratory workshop with a precision of 3/1,000ths of an inch. Here, too, several "hush-hush" war inventions were tried.

During the war, as the accompanying portrait shows, Mr. Trotter acted as a private in the National Guard (City of London Volunteer Regiment). He was also Chairman of the Committee formed by the Illuminating Engineering Society to study the measurement of candle-power yielded by flares and star-shells, some of whose work was described by him in a paper read before the Illuminating Engineering Society in December, 1918. He was keenly interested in the problem of lighting rifle ranges, discussed before the Illuminating Engineering Society in 1915.

On one occasion he undertook a flight over London in an airship for the purpose of studying methods of "scientific darkening of lights" as a precaution in view of visits of hostile aircraft; some reference to his experiences was made in his Presidential Address in 1918, and his conclusions were of material assistance to the authorities in devising better methods of screening lights.

During Mr. Trotter's tenure of office in the Board of Trade he had at home a private laboratory devoted almost entirely to photometric work. It may be imagined that he was glad of the opportunity of greater leisure afforded by his retirement at the age of 60; he was then at liberty to become a member of Council of the Institution of Electrical Engineers, and to be elected President of the Illuminating Engineering Society (1917) and of the National Association of Supervising Electricians.

For three years he returned to consulting work, but has since retired to his present home in a small country village ten miles west of Salisbury, the old home of his wife (a poet and artist). Here he wrote his little primer "The Elements of Illuminating Engineering," at the request of Sir Isaac Pitman & Sons Ltd.

From the very commencement of the work of the Illuminating Engineering Society Mr. Trotter took a sympathetic interest in its affairs. He presided over the original meeting of the Association of Engineers-in-Charge, held in 1907, when the proposal to form an Illuminating Engineering Society was first made by Mr. L. Gaster. He participated in many discussions and in the work of the Joint Committees dealing with School and Library Lighting and the Standard Specification for Street Lighting. His inaugural address, delivered in December, 1917, was a classic review of the aims of the Society and of recent developments in illuminating engineering. One of his favourite subjects was nomenclature and symbols. This also came before his notice as a member of the National Illumination Committee, of which he became Vice-Chairman.

His only son was an officer in the Special Reserve of the Royal Scots when the war broke out; he was killed on October 12th, 1914, at the age of 20. Mr. Trotter has a daughter and grand-daughter, his son-in-law being Mr. H. C. Beck, F.S.A.

Illumination and Light

By A. P. TROTTER

Past President and Life Member of the Illuminating Engineering Society.

(Abstract of the Faraday Lecture, 1926, delivered before the Liverpool, Manchester, Dublin and Cardiff Centres of the Institution of Electrical Engineers.)

THE purpose of this lecture is to put before you, in as plain language as the subject permits, some account of a branch of the industry of electrical engineering, of the early investigations which led up to it, and a very elementary sketch of the scientific theories of the present day, which are so full of promise.

No one man could discuss the whole work of the Institution of Electrical Engineers: to attempt this would be but to give a superficial sketch. If I were to tell you of the occupation in which I have spent more than half of my working days it would be but a dull tale of administration of official regulations, of control rather than progress, of bureaucracy rather than production—in short, red tape. But I have been invited to tell you something of a branch of engineering and its underlying science which has been a hobby of mine for some forty-five years. I will take some practical applications first, and the theory afterwards. I am glad that both can be associated with the work of Faraday.

The emblem of the Institution of Electrical Engineers, which is found on the seal of its charter, is the head of Michael Faraday. In 1821 Faraday discovered that a wire carrying an electric current would revolve round a magnet, and that if the wire were fixed—the magnet, free to move—would revolve round the wire. He seems to have kept this problem at the back of his mind for ten years, while he pondered and experimented, and in 1831 produced what he called his "new electrical machine," the first dynamo. On this is founded the whole industry of electrical engineering.

Faraday, as known to men of science, worked on original lines; he belonged to no recognized school of thought. His contemporaries seemed to be pursuing their inquiries into physical science in a different way, and expressed their results in other fashion. Faraday was known to the public for his lucid explanations and for his charm of delivery; as a lecturer he stands, perhaps, unrivalled. I never saw him. I began to attend the juvenile Christmas lectures at the Royal Institution in 1886, and he died in the following year.

When the industry of electrical engineering came into existence forty-four years ago (I reckon from the Paris Electrical Exhibition of 1881), its chief object was to produce light; and it is of light that I wish to speak.

Sir Humphry Davy, in the year 1800, found that when an electric current leaped across between two sticks of charcoal a very bright light was produced. The electric arc remained a laboratory experiment for 47 years, when a self-regulating arc-lamp was invented. Only a few months after Faraday described his "new electrical machine" others began constructing elementary dynamos. But practical machines were long in coming; the principles of design were not understood, their development was a matter of tedious experiment and gradual improvement. Twenty years later such machinery had not been produced, and Faraday was still reporting to Trinity House on the proposed use of electric light for lighthouses. Thirty-one years after Faraday had reported to Trinity House on a proposal to light buoys by incandescent lamps containing platinum spirals, Edison (in 1878) turned his attention to the same impracticable idea, but in the following year Swan publicly showed vacuum lamps with carbon filaments at Newcastle.

In these days of impetuous activity, zealous ambition, and strenuous competition, it is difficult to imagine the deliberate work of the middle of the nineteenth century. Ninety years have passed since Faraday produced electric current from his "new electrical machine." Divide that period into halves, and we have the year in which Swan was making the first practical carbon incandescent lamps.

There is another striking difference between the experimental researches of Faraday and those of to-day. His apparatus was nearly all made with his own hands and the help of one assistant. It was of the utmost simplicity. To-day, nearly all experimental research in the advanced branches of physics is carried on in laboratories equipped with highly complicated and expensive apparatus called for by the ever-increasing degree of accuracy of measurement. Great skill and training are required. Faraday's self-training was long, and his manipulative skill in research was as remarkable as his dexterity in lecture demonstrations; but the brass and glass of a modern laboratory would probably bewilder him.

Let us pause for a moment to consider what science is. We have observations, deductions, and statement of facts. The denial of facts might be added. Empedokles, in 420 B.C., thought it necessary to record the fact that darkness is not a real thing, but the absence of light. We obtain knowledge of our facts by observation, but this does not constitute science. Years may be spent by an astronomer in cataloguing stars, or thousands of lines observed in a spectroscope may be measured and tabulated, or patient daily records of rainfall and temperature may be made for a lifetime; but the work does not become scientific until the deduction of some principle is made, setting the facts into order or classification, and offering a guess at an explanation, which is called an hypothesis. Lastly, the worker must have the power of stating the principle in an intelligible form. When the statement has been made, it often indicates where further facts may be looked for, and when these are found in the places indicated the principle acquires increased value.

Science, then, consists in classifying observed facts into groups, and in stating their relationship. And now, disregarding the old Greek who said that in considering what science is we should not content ourselves with metaphors, we may liken the progress of science in Faraday's time to the flow of a steady stream. A man like Whewell could survey it all. A man of ordinary ability could swim in it, and anyone could paddle in it. To-day it pours as a torrent; the old landmarks of the standard books are swept away; it overflows its banks and floods new regions, sometimes fertilizing, sometimes devastating them; cataracts of scientific papers are published by the societies, and deep whirlpools of metaphysics threaten to drown the ordinary man.

I invite you to wade with me to-night in the river of science. I will not take you out of your depth in mathematics, and if there should be a strange word or two, you need not stumble, but may walk round them.

Let us first look at the practical side, and then turn to the still incomplete theory of light.

After Swan had produced a practical incandescent lamp, the young industry struggled on for six years under misguided legislation. At the close of 1888, a memorable year in its history, when the impossible provisions of the Electric Lighting Act of 1882 were withdrawn, public electric supply became possible, the old Society of Telegraph Engineers and Electricians became the Institution of Electrical Engineers. By that time the elements of the industry were being taught in colleges, but the chief opportunity for exchange of experience, announcement of new discoveries, and—perhaps as important as any other feature—for discussion and controversy, was offered by the meetings of the Institution.

The carbon incandescent lamp of eight candle-power became the unit by which the output of electric lighting works and their plant-capacity used to be reckoned. For example, thirty years ago, at Liverpool, it was stated that the equivalent of 54,000 lamps were connected; at Manchester, 60,520; at Cardiff, 10,843; and at Dublin, 16,000.

What was, and what, indeed, is now an eight-candle lamp? Anyone buying half a pound of tea would assume, and perhaps check the eight ounces; but no ordinary buyer ever thinks of measuring the candle-power of a lamp, or insisting that it should give the candle-power at which it is rated. There was only a mild protest a few years ago when lamp makers as a body declined to state the candle-power of their lamps, but rated them by the consumption of energy in watts. This

may seem to be apathetic on the part of the public, but it is, in fact, an indication of confidence in, and a tribute to the good work of, the lamp makers.

Photometry.

The unit on which all practical measurements of light is based is candle-power. This unit has been agreed upon and is maintained by the National Laboratories of Great Britain, France and the United States by the interchange and comparison of standard electric lamps.

Parliament in its wisdom decreed by the Metropolitan Gas Act of 1860 that the light emitted by a spermaceti candle with a special wick, six to the pound (neither length nor diameter being mentioned), and burning 120 grains of sperm per hour, should be set up as the official standard, but only for the purpose of testing London gas. The candle is a time-honoured piece of apparatus, and Faraday gave juvenile lectures on more than one occasion on "The Chemistry of a Candle."

The so-called Parliamentary candle has been superseded, but the *unit* remains. The science of measuring light dates from 1750, and is called photometry. The light of a candle does not vary much in different directions except downwards, where the light is cut off by the candle itself. There is a Japanese proverb, *Todai moto kurashi*—the darkest place is just below the candlestick. The light emitted horizontally from a lamp was formerly taken as the light to be measured. When the electric arc came, its horizontal candle-power being insignificant, the maker hunted for the maximum direction, and generally found the candle-power to be about 1,000, and called it a thousand candle-power arc.

Time does not permit me to describe the construction of photometers, the instruments by which light is measured, or the art of using them. Visual photometry consists in illuminating a white screen by the lamp to be measured, illuminating another screen by the standard lamp, and adjusting the apparatus until the brightness of the two screens appears to be identical. The adjustment generally consists in moving one of the lamps. If the distance is halved the illumination becomes four times as great; if it is reduced to one-third, nine times as great. The illumination varies inversely as the square of the distance. The only ratio that the eye can determine with any accuracy is that of unity or equality. A trained observer can repeat measurements with an error of not more than one-fifth of one per cent., and with favourable conditions can detect a difference of half of that amount.

With the coming of modern electric lamps it became necessary to take the average in all directions. The ultimate way of arriving at this average is to make measurements in a considerable number of different directions, and to take the average. But this is a tedious job, and many methods have been proposed for simplifying it.

One of the conditions for high precision in photometric measurements is identity of the colour of the light of the standard lamp with the light to be measured. The subject of heterochromatic photometry, as it is uncouthly called, is full of interest and controversy.

When Lambert in 1770, in his "Photometria," wrote "the eye is the only judge," he regretted that the eye lacks an instrument like a thermometer, so that when left to itself it might give judgment. Several attempts have been made to produce such an instrument; but there is a risk in all electrical, thermal, photographic, and other chemical methods of measuring something that is not light.

The most promising at present is the photo-electric cell, which consists of a glass bulb, coated inside with silver, and this again coated with a suitable film such as potassium hydride. An opening in the metallic coating forms a window. The metallic coating is connected to the negative terminal of an electric battery, and an insulated wire in the bulb is connected to the positive terminal. When the cell is in darkness no current passes, but when light enters the window a current passes, which may be measured with a galvanometer, and is directly proportional to the light received.

Illuminating Engineering.

Having got our light, and some idea of how it may be measured, what do we do with it? We illuminate objects, intelligently or stupidly, economically or wastefully. During the last 15 years or so, a branch of engineering has been developed with the object of directing both the artificial light of lamps and natural daylight (to use Telford's phrase) "for the use and convenience of man."

With the progress of civilization, the use of artificial light has continually advanced from the oil lamps and torches of ancient times to the gas lighting of the nineteenth century, and this, in its recent development, is still competing bravely with the electric lighting of to-day. Their competition is valuable to both industries.

Whether civilization and the intensity of artificial lighting have both reached their beneficial limits is a moot point; artificial lighting in some cases has arrived at a brilliance which is harmful in its profusion. But the position of civilization is not a matter for this evening's consideration.

During the last fifteen years which have been mentioned, there has been an extended use of photometers, not for measuring candle-power, but illumination. Lamps are only a means to an end. What is wanted is not means and appliances, but the result. We want light merely to produce illumination. A surface when struck by light receives illumination. Whether the surface appears to be bright or not depends on its reflecting power or colour. Illumination consists of two factors, candle-power and distance. The unit by which illumination is measured is the illumination from a source of one candle-power received at a distance of one foot by a surface facing the light, and is called one foot-candle. Let us assume that we have lighted a room, and that the result appears to be good—for "the eye is the only judge." When we have measured the result in foot-candles, we can plan similar work by applying very simple rules and calculations, or, if the conditions are varied, we can vary the plan accordingly. There is an abundance of illumination photometers of different types, and with these the degree of illumination required for different purposes can be measured.

For the study and development of this subject, the Illuminating Engineering Society has been founded. Its work is very varied, and includes gas and oil lighting. If it had done nothing but collect statistics of the amount of illumination required for factories of different kinds, for domestic purposes, libraries, schools and street lighting it would have done good work. It has done this and much more.

The cottager in a village uses a candle or a paraffin lamp, generally without any shade. He can stare at them without hurting his eyes. But with an incandescent gas or oil burner the brightness, that is to say the light emitted per square inch, is some ten times greater, and with a modern gasfilled electric lamp it is many hundred times more intense. A 40 candle-power lamp is very different from forty candles. These would be distributed about a room, but with an electric lamp the light comes from a small concentrated source, and should be hidden from sight or softened by a translucent shade. In factories or large buildings there is no objection to unshaded lamps if they are placed so high as to be out of range of ordinary view.

The subject of "glare" has received much attention from illuminating engineers. It is not a question of intensity of light, but of contrast. The headlamps of a motor car may give a blinding glare in a country road on a dark night, but the same lamps are hardly noticeable in bright sunshine, where the eye is receiving several thousand times more light.

Street lighting is an interesting and difficult subject. In the days of the old "bats-wing" gas burners, street lamps were little else than beacons to show the direction of the street. The amount of illumination desirable for different classes of streets has been studied by trial and error. This is merely a matter of opinion. But the results can be measured and recorded, the heights of lamps, their spacing and candle-power, and the types of lanterns can be settled and specified. Gas lighting can easily compete in this work: it is merely a question of

cost. The minimum for good street lighting is from one twentieth to one-tenth of a foot-candle on a horizontal surface midway between two lamps.

Illuminating engineers have long lists giving the illumination which experience has shown to be necessary for various purposes. For example, at least one-half to one foot-candle is needed for railway platforms and warehouses. For domestic purposes illumination varies from about one foot-candle in bedrooms to four or six for reading and working. A dining-room table is comfortably lighted at three or four foot-candles, but from twelve to fifteen is needed for a billiard table.

The Factory Department of the Home Office has recommended certain minimum illuminations for various factories; in general, three foot-candles for ordinary purposes, and five for fine work, up to 20 or more in special cases. No compulsion should be necessary to enforce this, for factory managers are becoming aware that accidents can be reduced and output of production and the quality of work can be increased by better lighting. This means not only higher candle-power, but the judicious arrangement of lamps and reflectors for different kinds of work. The cost of lighting a factory is a small fraction of the annual overhead charges.

Artificial light is more yellow than daylight; in other words, it is deficient in blue and green. Some 33 years ago I made experiments, and suggested in a paper read before the Institution of Electrical Engineers, that the superfluous red and yellow rays might be cut off by tinted glasses, to produce an imitation daylight. About 14 years ago I tried in vain to induce glass makers to produce the necessary glasses. Others have succeeded, and picture galleries are now lighted in this way, and "daylight" lamps are being used for colour-matching, not only of textile goods, but for grading flour and other industrial purposes.

The illumination out of doors, in bright sunlight, is about 8,000 foot-candles. This can be measured by ordinary photometric methods. The daylight in a room on a grey day seems at first to be a difficult thing to measure, depending as it does on the time of the year, the time of the day, the amount of cloud, and so on. It occurred to me, some 30 years ago, that the daylight in any part of a building could be compared with the daylight received from a small portion of the overhead sky out of doors on the same day, and at the same time of day, and thus a standard of comparison could be found for that part of the building. There was no demand for such measurements until 12 years later, when the same idea occurred to Mr. P. J. Waldram, who used the form of photometer that I had designed. He found, for example, that the fraction received in the British Museum reading-room is seven thousandths, and on the Woolsack, in the House of Lords, four ten-thousandths of the illumination which would be found if all the buildings in the neighbourhood were demolished and the illumination were received from a hemisphere of grey sky. Mr. Waldram and his son have done much valuable work in connection with the daylight illumination of buildings. At the National Physical Laboratory, experimental sheds have been erected for studying the daylight illumination of factories and picture galleries and offices on this principle.

Part II (*Abstract*).

In 1846 it dawned upon Faraday that there was a similarity between lateral disturbances of magnetic lines of force and the vibrations of light. Iron filings dusted over a magnet arrange themselves in beautiful curved lines. Whether they are still there when the iron filings are removed, or whether they are conveniences of thought like lines of latitude and longitude, is another matter. Faraday treated them as mere directions along which something called force acts. In 1864 Clerk Maxwell showed that electrical disturbances or vibrations are transverse to or across the direction of propagation; and the velocity being so nearly that of light, we have strong reason to suppose that light is some kind of electromagnetic disturbance.

We know that sound is not a material thing. It is one of the ways in which air behaves. Light, too, is not a substantial thing, but, according to that hypothesis, consists of rapid tremors of something that has been provisionally called ether; and electricity seems not to be a thing, but the way in which something behaves.

The statement that Newton held only one view about the nature of light, namely that it consists of small particles or corpuscles, has been copied from one text-book into another. But, on the contrary, his writings show that he gave much more attention to the wave theory. There is not a word about corpuscles in the first edition of Newton's "Opticks," and it is only at the end of the second edition that he seems to tire of the subject, and asks, "Are not the rays of light very small bodies emitted from shining substances?" He left the matter in a very unfinished state; and now, 200 years later, the theory is still incomplete.

The visible part of the spectrum only occupies about one octave—that is to say, there are about twice as many vibrations per second in violet light as there are in red light. Beyond the red end of the spectrum are about six octaves of invisible heat rays. Until recently there was a gap here of ten octaves, but this has been filled, partly by heat rays and partly by electrical vibrations. This brings us to wavelengths of a few inches, detected by Hertz. It is in this region that we may look for the discovery of the true nature of a light wave. Eight octaves more and we come to waves used for ordinary broadcasting. Beyond the violet end there are several octaves of different kinds of ultra-violet rays, and finally the X-rays discovered by Röntgen, a few hundredths of a millionth of an inch in length. In all, some 50 or 60 octaves. The secret of producing light without heat is known only to the glow-worm and the firefly. They have been severely examined about this, but so far they have declined to give any explanation of their behaviour.

From the X-rays comparable in size with atoms to the waves used in wireless telegraphy and telephony, which may be measured in miles, the vibrations are of the same nature. Vibrations, but of what? The ether is not an observed fact. Vibrations have been observed, and all that was asked of the ether was that it should vibrate, but it has never been observed because it has unbroken continuity. The great mistake in the older theories seems to have been in treating ether as matter. Maxwell's equations expressing the electromagnetic theory of light is accepted by mathematicians, but to put it into plain language has baffled every one of them. But that is not the business of mathematicians. They are content with their equations, and some of them do not care whether there is an ether or not; some indeed say that the hypothesis of an ether is useless, unwarranted, and unnecessary. The fact is that our ideas both of energy and of matter are in the melting pot. There is probably nothing seriously wrong with the undulatory theory of light, and the complete theory may appear any day. The undisputed fact that the velocity of a train of waves is reduced while light is passing through glass, but the original velocity is exactly resumed when it emerges, appears to be one of the strongest proofs for the existence of a medium.

The most recent researches can be presented only in advanced mathematical language, often mixed with metaphysics, and cannot be put into plain words. Physics describes what we observe and offers an explanation. Mathematical metaphysics discusses what we imagine, and offers us an assertion. We are told that space is a four-fold extension endowed with physical properties. To endow empty space with physical properties in order to explain observed facts seems rather like insisting that water flows because it has the property of aquosity.

I have discussed vibrations or undulations without giving the vaguest mental picture of what such an undulation is like. So far as I know, no mathematician has been able to describe it in any but mathematical terms. We need another Faraday, and I hope that some of my audience, even those to whom science has little attraction, will wish to know more of the life and personal character of the great and good man, Michael Faraday, in whose honour this lecture has been given.

POPULAR & TRADE SECTION

COMPRISING

Installation Topics—Hygiene and Safety—Data for Contractors—Hints to Consumers

(The matter in this section does not form part of the official Transactions of the Illuminating Engineering Society; and is based on outside contributions.)

Shop-Window Reflectors for Electric Lamps

By H. LINGARD

THE object of good illumination is to use as much light as possible in lighting up the object to be seen, and to avoid light from the source reaching the eye direct. This principle particularly applies to the illumination of shop windows; the aim in this case being to use as much of the available light flux from the lamp as possible and to project it on to the display. The minimum possible light should escape into the street, and the source of light itself should be screened from the view of the passer-by. The common practice of hanging bare lamps in a window is greatly to be deprecated, not only on the score of the glare which it produces, but also on the grounds of efficiency. A great

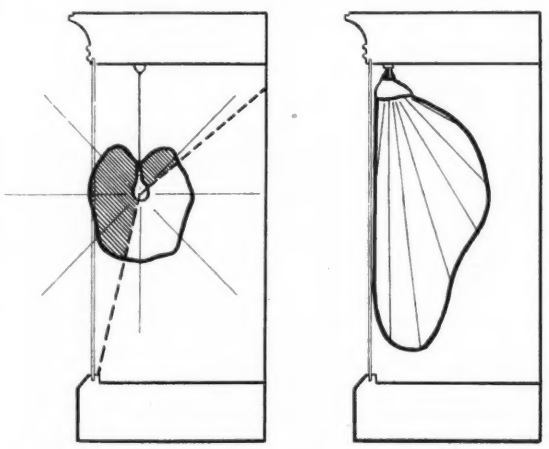


FIG. 1.—Comparing effect of bare lamp (a) and a reflector (b) in directing light forward and downward in a shop window.

proportion of the light is sent through the window, lighting up the street, and a large amount falls on the ceiling and performs little useful work. A consideration of Fig. 1A will indicate that such a lamp sends light directly into the eye, and it is obvious that the efficiency of such a system is very low.

The problem of lighting the shop window may be considered similar to that required on the stage. In both cases it is essential to conceal the sources of light.

The following represent some of the chief features required in a satisfactorily designed shop-window reflector:—

(1) It should direct the light forward and downward (see Fig. 1B).

(2) It should have a high efficiency, that is, should reflect as much of the light as possible, and direct it into a sphere of usefulness.

(3) It should be readily cleaned, and not deteriorate in service.

Most reliable shop-window reflectors of the present day fulfil these conditions, and below are given a few notes concerning the chief types that are in use.

Silver Glass Reflector.—Silver is deposited on the outside of a suitably shaped piece of glass. The glass is usually indented with either corrugations or hammering in order to avoid streakiness in the reflected light. For mechanical reasons a heavy coating of copper is deposited on the silver, which, in turn, is covered by a coating of suitable enamel. It will be obvious that such a method of construction ensures that the reflecting silver always remains bright and untarnished.

Silver Deposit on Metal.—In this instance silver is deposited on the interior of a corrugated metallic shell, usually copper, and the silver is protected against tarnish by a fine layer of transparent lacquer.

Prismatic Reflectors.—This type of shop-window reflector depends upon the well-known principles of internal reflections from prisms, and in modern developments the mouth of the reflector is covered by a prismatic glass which still further controls the light by refraction.

Mention has been made in each instance of the elimination of streakiness which would be obtained if perfectly smooth mirrors were employed. The flutings and corrugations employed to achieve this are quite obvious in Fig. 2, in which a number of typical shop-window reflectors are shown.

Contour.—Fig. 3 illustrates the cross section of a typical reflector and approximately indicates the optical principles involved in the control of light. It will be seen that due to the assymetry of the reflector the light is either directed downwards or forwards, the curvature of any part of the reflector being designed to bring this

FIG. 2.—Typical forms of Reflectors for shop-window lighting.

about. Reflectors of similar curvature would not be suitable for lighting all kinds of windows irrespective of their shallowness or depth, and in practice at least two different types of reflectors are used:—

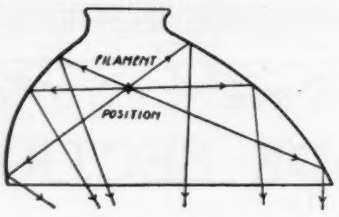


FIG. 3.—Cross-section of typical shop-window lighting reflector.

(a) The intensive pattern for general use where the ratio of depth of window to height is less than 1.

(b) Extensive pattern for use in those instances where the depth exceeds the height.

This is made quite clear in Fig. 4, which also gives some indication of the kind of polar curve given by each of the reflectors. Care should be taken in any case to ensure that the right type of reflector is employed in accordance with the manufacturer's recommendations.

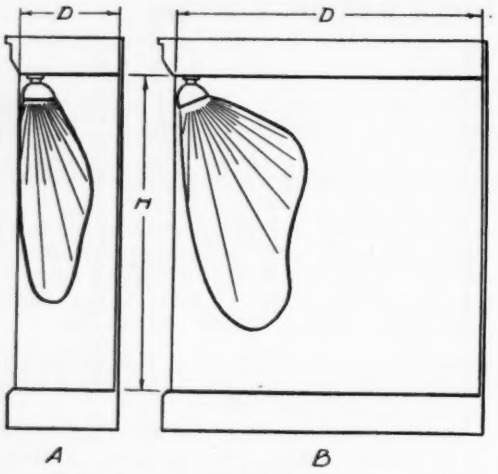


FIG. 4.—Showing the types of polar curves suitable for windows of different dimensions.

Spacing.—The longitudinal spacing of the reflectors will obviously vary according to the district in which the shop is situated, and also where coloured lighting is contemplated. In brightly lighted districts it is impossible to have too much light, and it really becomes a question of practical politics. At the present time it is common practice to install a reflector with a 100-watt lamp every 1 ft. frontage of window when shops are situated in main thoroughfares. In side streets less intensity is possible, but not always desirable, and in any case it is recommended that the individual reflectors with 100-watt lamps should not be spaced at a greater distance than 3 ft. apart, for if this distance is exceeded patchiness and dark spots are almost certain to ensue.

FIG. 5.—Accessories for shop-window lighting.

Accessories.—Most manufacturers arrange so that colour screens, etc., can be attached to their standard reflectors. Some of these accessories are illustrated in Fig. 5.

It will now be obvious that the contour and general design of the shop-window reflector has a definite purpose to perform in the control of light, and it cannot be too strongly emphasized that equipment should be installed strictly in accordance with the manufacturer's recommendations, in order to make certain that the light is being directed on to the display. The writer has seen a number of instances in which reflectors have been mounted the wrong way round, so that most of the light was directed into the street.

Sheffield Illumination Society

The members of the above Society had another very educative lecture in the Council-room at the Montgomery Hall, Surrey Street, Sheffield, on March 18th, the lecturer on this occasion being Mr. George Herbert, of the Benjamin Electric Ltd., London, and the subject, "A Talk on Lighting."

Mr. Herbert gave a short history of the development of artificial light from the time of our ancestors to the present day, and various types of candlesticks, tinder-box, etc., that formed the illuminant in those days were exhibited. Another interesting exhibit shown was the "hour candle," similar to those used in the days of King Alfred.

The lecturer showed how eventually light came to be measured and treated on a scientific basis. As the carbon lamp went out of date it was followed by the metal-filament lamp and other more efficient sources.

Technical data were also explained by Mr. Herbert what a lumen was, how to arrive at the candle-power of an electric lamp, etc., and how to take measurements of light by means of a light-meter.

The question of the type of reflector to be used for street-lighting purposes, and workshops, etc., was given very careful consideration, and the necessity of having fittings and reflectors placed at such a height, and also the lamps being correctly spaced, that the traffic on the roads is not at all inconvenienced by the effects of "glare" from the various types of lanterns, was also pointed out. Sketches were made on the blackboard illustrating this important matter.

A very keen discussion followed the lecture, and many questions were dealt with, all of which helped very materially in making the evening such a marked success.

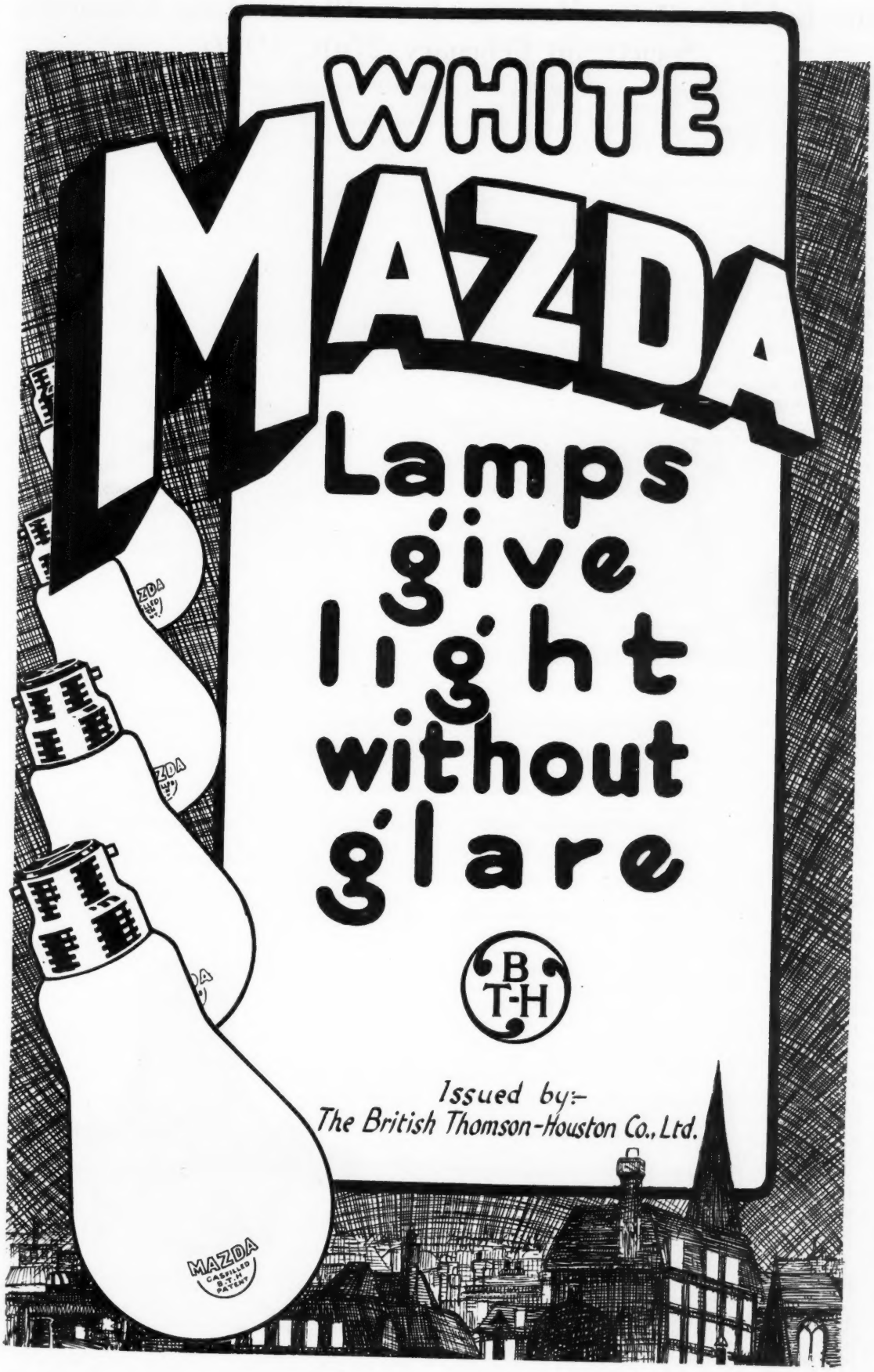
Mr. J. F. Colquhoun (Public Lighting Engineer), who presided, said the Society were very much indebted to Mr. Herbert for the trouble he had gone to in making the lecture so very interesting and instructive.

The meeting closed with a very hearty vote of thanks to the lecturer.

The Smokeless Age

But a short time ago we were recording the address given before the Circle of Scientific, Technical and Trade Journalists by its Chairman, Mr. J. S. Owens, Secretary to the Advisory Committee on Atmospheric Pollution. In a talk broadcasted from the London station on March 9th, he again drew attention to the drawbacks of pollution of the atmosphere, and referred to the Smoke Abatement Bill announced by Mr. Neville Chamberlain, the Minister of Health. As the Bill will presumably be based on the recommendations of Lord Newton's Committee on Smoke Abatement, Dr. Owens gave a summary of its conclusions. He forecasted the general tightening up of existing smoke-prevention laws, and the placing of a legal obligation on manufacturers and users of engines to adopt the best practicable means of eliminating smoke. In regard to fireside and kitchen smoke, Lord Newton's Committee recommended that every encouragement should be given to the cheapening of the supply of gas and electricity, and that municipal authorities should not make profits out of their gas and electricity undertakings in order to relieve the rates. It was further suggested that Central Housing Authorities should decline to sanction any housing scheme unless the plans provide for the adoption of smokeless methods of heating and cooking. The latter would be a most important provision in view of the very large volume of domestic smoke at present produced.

Dr. Owens, therefore, suggested that the Ministry of Health should fix a standard of permissible smoke, which should be enforced by law, that Government subsidies or State help should be given only to housing schemes which provided for smokeless cooking and smokeless fires, and that power should be given to local rating authorities to make a rebate of, say, 3d. in the £, from the cleansing or sanitary rate to owners or occupiers of property whose houses are equipped solely with smokeless appliances. The last provision would amount, in effect, to a tax on smoke, and afford a preferential tariff in favour of pure air and more sunlight.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Some Exhibits at the Meeting of the Illuminating Engineering Society on February 25th, 1926

IN connection with the discussion on the B.E.S.A. Specifications for portable photometers and industrial reflector-fittings, there were a number of exhibits of apparatus, typical of modern illumination photometers and reflectors.

PORTABLE PHOTOMETERS.

Amongst the former may be mentioned the "Luxometer," shown by Messrs. Everett, Edgcumbe & Co. Ltd., which is a familiar instrument which enables illumination to be measured by the inspection of a standard white test-plate; or, alternatively, the brightness of a distant object to be examined by direct inspection through the eye-piece; the Benjamin Lightometer, which is also familiar, and is of a very simple form, based on the observation of a movable grease-spot disc; and the new "Niam" photometer, supplied by Messrs. Geo. Main et Cie, of Paris, which was recently described in this journal.

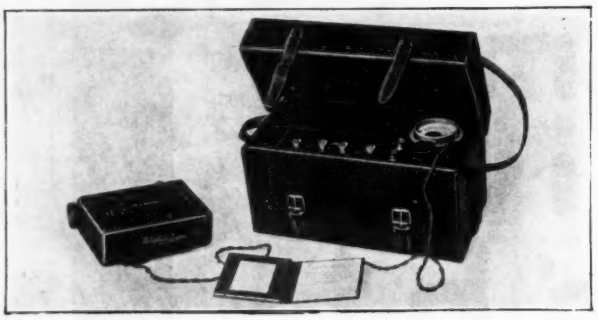


FIG. 1.—General view of Holophane Lumeter (New Model).

The latest model of the Holophane Lumeter, which was shown by Mr. H. S. ALLPRESS, has several interesting features. In principle the design follows the well-known methods associated with this instrument, but there are numerous improvements in detail, enabling greater precision to be obtained. The instrument is now made of a light metal alloy covered with morocco-grained vulcanite. An unspillable 4-volt accumulator, with switchboard, rheostat and voltmeter, are now accommodated in the leather carrying-case. Connections are made by quadruple flexible leads and four-pin plugs to the Lumeter proper, so that the voltmeter is independently connected directly across the lamp terminals. The new design permits of the lamp being finally clamped in its holder and the slides and arrangements for fixing of the lamp in calibration do not form part of the electrical circuit. The scale with multiplying devices enables readings from 0 to 4,000 foot-candles to be obtained, so as to meet the requirements of both forms of instruments mentioned in the B.E.S.A. Specification.

In addition, in order to meet Clause 5 of the specification, a new test-surface and holder has been designed. This surface consists of an optically ground opal plate, protected by a metal case. The new holder enables the angle of incidence of the light and the inclination of the test-surface to be read on a single scale, the test-plate being mounted on a ball-and-socket joint, and capable of being mounted on a camera tripod or a special base-plate. The latter brings the test-plate so close to the actual plane of test that correction for its thickness is unnecessary.

Fig. 1 shows a general view of the instrument; the test-plate, as applied to the taking of normal readings, is shown in Fig. 2. The rotatable arm carries a lens at one end, and a screen with cross lines at the other is so set that the pointer attached to it is over the 0° division on the angular scale. The whole apparatus is then swivelled until the image of the light-source formed by the lens falls on the cross lines. The test-surface is then truly normal to the incident light, and the angle of inclination of the test-surface from the horizontal is automatically indicated by the other pointer hanging behind the same scale. Since the holder is provided with spirit levels, the test-surface can be set for horizontal illumination tests. When this is done the optical pointer can be turned independently until the image again falls on the cross lines. The position of this pointer then indicates the angle of incidence of the light to the normal to the test-surface.

EXHIBITS OF REFLECTOR-FITTINGS.

Mr. R. A. IVES exhibited the Benjamin Biflector fitting (see Fig. 3), which is specially designed to comply with the recommendations of the Home Office Departmental Committee with regard to angle of cut-off and prevention of glare; also with the B.E.S.A. Specification No. 232—1926.

FIG. 2.—View of New Test-plate, with Angular Scale.

The design is such as to increase the candle-power in the lower hemisphere, and distribute it uniformly over as large an area as possible, at the same time avoiding glare by shading the source from direct vision over those angles approaching the horizontal. The unit combines two special features, a main reflector and an anti-glare shade. The reflector is mainly to provide illumination at those angles at which the light is intercepted by the anti-glare shade. The interior reflecting surface of the anti-glare shade assists this object, whilst the exterior surface helps to diffuse light directed on to it from the top reflector.

FIG. 3.—General view of Benjamin Biflector Fitting.

The angle of cut-off of the Biflector screen is approximately 25°; yet, owing to the special design, a very wide distribution of light is obtained. Analysis shows that the reflecting surfaces of the fitting deal with 71 per cent. of the total luminous energy. With an angle of cut-off of 25°, the main reflector (0° to 80°) deals with 41 per cent, the anti-glare shade (80° to 115°) with 30 per cent., and the direct light (115° to 180°) is 29 per cent. The utilization efficiency of this unit is of the order of 60 to 65 per cent.

Mr. H. S. ALLPRESS also exhibited examples of Holophane prismatic reflectors for industrial lighting, pointing out the accurate light-control obtained by the use of prisms. In the industrial types the outer prismatic surface is protected by a strong metal spinning, which is removable. He also drew attention to the fact that with such reflectors quite a high angle of cut-off could be obtained, and that the filament, when seen at all, was visible against a background of reflector almost equally bright.

FIG. 4.—Standard Holophane Industrial Reflector.

Mr. G. J. WELLS (Engineering and Lighting Equipment Co. Ltd.) also exhibited a form of metal reflector which had been specially designed to screen the filament from view, and give the distribution of light usually desired in industrial lighting installations.

Artificial Sunlight Exhibition

Held at the Middlesex Hospital, March 11th-16th 1926

By A CORRESPONDENT

SOME indication of the interest now being excited in the possibilities of sunlight and artificial radiation in the treatment of disease was afforded by the Exhibition arranged at the Middlesex Hospital this month. There were in all twenty-two exhibitors, and quite a variety of lamps was shown. In view of the many forms of these lamps now being developed, one is not surprised at the caution in Dr. Percy Hall's opening address, that they need to be used with discretion. (The hospital authorities, taking no chances, furnished every visitor with a pair of dark goggles at the entrance to the exhibition!)

Broadly speaking, the lamps fall into two classes, those using the quartz tube mercury-vapour lamp and those utilizing arcs between special electrodes. At the first stall visited, that of the Cox-Cavendish Electric Co. Ltd., both types are on view. One noticed particularly a compact new portable type of mercury lamp. There were also incandescent lamps provided with a red screen—designed to furnish infra-red radiation, which is sometimes mixed with the shorter wave radiation from the more actinic lamps.

Messrs. Watson & Sons (Electro-Medical) Ltd. had a representative collection of lamps, some of which were recently illustrated in this journal. We were particularly interested in the cadmium photo-electric cell, which it is hoped will prove a useful means of measuring ultra-violet radiation. It has the distinctive quality of being affected only by invisible ultra-violet energy, and it is believed that different wavelengths may be capable of separation and examination by this means.

Other comprehensive exhibits were arranged by The General Radiological and Surgical Apparatus Co. Ltd., Messrs. Allen & Hanbury and Newton & Wright Ltd. ("Westminster" arcs), the Medical Supply Association Ltd., the Dowsing Radiant Heat Co. Ltd., and the Western Dental Manufacturing Co. Ltd. The latter's exhibit furnished an indication of the use of radiation in dental treatment—a comparatively new development. We also observed that Messrs. Duncan Watson & Co. Ltd., who are associated with ordinary lighting and kinema projectors, etc., have also entered this field. At the stall of Messrs. John Bell & Croyden Ltd. (incorporating Arnold & Sons) an effective object lesson in the use of the spectroscope was given, visitors being invited to see for themselves the difference in the spectrum of daylight and the mercury lamp (the ultra-violet portion of the latter being rendered visible by means of a fluorescent screen). In view of the importance of discrimination between the spectra of different lamps, one was rather impressed by this evidence of spectromatic study and the spectrum maps presented. One's attention was also drawn to an ingenious alpine sunlight arc, operating four carbons in series, exhibited by this firm. To the eye, the light has a general resemblance to sunlight, and the spectrum was shown to be continuous.

The Hewittic Electric Company Ltd. had on view a very adjustable form of quartz lamp, mounted on a special base. Mr. J. R. Quain showed the new arc lamp with quartz glass envelope, recently exhibited before the Illuminating Engineering Society and now being used in London Hospital, and also a novel apparatus, in which the arc and quartz elements emitting radiant heat energy were mounted together within the same reflecting surface. It was appropriate that a neighbouring stall should be devoted to the display of the Thermal Syndicate Ltd., whose "Vitreosil" glassware is well known in the lighting field; on this occasion, however, the exhibit consisted mainly of quartz glass laboratory work showing very finished workmanship.

Another very comprehensive display was that of Kelvin, Bottomley & Baird Ltd., who, besides lamps for medical treatment, had several special exhibits, notably the K.B.B. Microscope Illuminant and Macbeth Daylight Lamps. Amongst other exhibitors may be mentioned Rouse & Sons Ltd., the Sterling Corporation Ltd., the Standard Ozone Co. Ltd., the British Hanovia Quartz Lamp Co. Ltd., Ajax Ltd., Ozonair Ltd., A. E. Dean & Co., T. Clark & Son. At the entrance, Messrs. Ballière, Tindall & Cox had a stall devoted to books and periodical literature dealing with light.

The Lighting of Printing Works

A LECTURE on the above subject was delivered by Mr. L. Gaster on March 23rd at a meeting arranged by the Joint Industrial Council of the Printing and Allied Trades (Aylesbury, Chesham and High Wycombe Branch). The meeting took place at Aylesbury, where several printing works are situated. The Vice-President of the Council presided, and the engineers of the local gas and electric supply undertakings were also present. There was a good attendance, both management and workers at leading printing establishments in the vicinity being well represented. The lecture was illustrated by a comprehensive series of slides. After a brief exposition of the fundamental principles of industrial lighting, examples of lighting installations in many printing works were shown, some dating back to a number of years ago, others illustrating the latest methods. The different sections of a printing works were discussed in turn, and reference was made to the important researches being undertaken by the Committee on Illumination working under the Department for Scientific and Industrial Research. Amongst the exhibits was a model show-window equipped with colour-changing devices, loaned by the E.L.M.A. Lighting Service Bureau. This proved very useful, and was much appreciated by the audience, as it enabled many problems in lighting to be illustrated; especially the difference in appearance of coloured objects when seen by ordinary and "daylight" lamps—a question of importance in connection with colour printing. The discussion led to many interesting problems being raised, amongst these being the question of direct reflection of light off the surfaces of new and bright type. The avoidance of this is rendered somewhat more difficult by the fact that the reflected light from masses of type comes at so many different angles.

Mr. Hazell, of Messrs. Hazell, Watson & Viney Ltd., in proposing a vote of thanks to Mr. Gaster, emphasized the great importance of good lighting as a means of reducing the fatigue of workers, and as a problem in which both management and operators could co-operate. He hoped that the new Factory Act would contain provisions for adequate and suitable lighting, a step which would be welcomed in the printing industry. The vote was seconded by Mr. Turnbull and carried with acclamation.

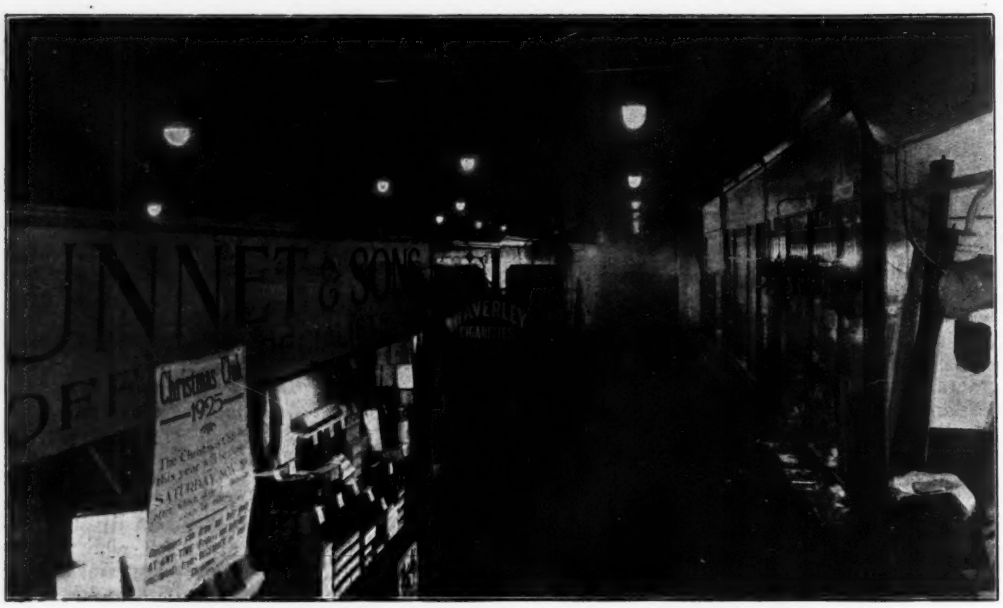


FIG. 1.—A night view of part of the Fulham Market, Walham Green, London, showing some of the 25 gas lamps used for general lighting purposes.

Reliable Lighting for the Covered-in Market

LONDON and provincial cities and many towns in this country have for some years now had their covered-in markets or arcades.

These shopping centres have distinct attractions to those who have very little time for shopping. The servantless housewife in particular welcomes the congregation in a comparatively small area of a number of shops from which she can make quickly all of her daily purchases of food and other household necessities. If, as is often the case, she has a child to take round with her, her appreciation of the covered-in market is enhanced on rainy days, as it is so easy to go from shop to shop without being made uncomfortably wet.

The general lines on which many of these markets are run are as follows: A commodious building, generally with glass roof, is constructed in a central position in the town or district, and is fitted up with rows of small and medium-sized shops or stalls, which are leased out by the market proprietors to tradesmen. The upkeep of the main building and stalls, the provision of washing facilities, the cleaning-up of the market, and the general lighting of the building are the main responsibilities of the market proprietors. The lighting, heating and other equipment on the stalls is, as a rule, a matter for the stallholder's attention, subject, of course, to rules and regulations drawn up by the market proprietors.

FIG. 2.—The gas lamps shown in this illustration are used for the double purpose of lighting a sweet stall in Fulham Market, Walham Green, London, and for keeping the boiled goods exhibited from becoming sticky. For this latter purpose the lighting units are fixed about 18 inches above the sweets. The heat radiated downwards from the gas mantles is sufficient to prevent the sweets from absorbing too much moisture from the air.

THE GENERAL LIGHTING OF THE MARKET.

When the building is being constructed, one of the important points to be considered by the proprietors is the artificial-lighting arrangements. Markets of this kind must be brilliantly lighted if they are to attract the crowd, but there is no reason why, in attaining this end, they should not be illuminated in a dignified, pleasant manner.

SAFETY FIRST.

It need hardly be pointed out that the space between the rows of stalls in these markets is not as wide as the ordinary shopping road. On certain nights of the week, therefore, the avenues are often densely packed with people, and this fact renders it imperative that the lighting system chosen shall be one which will never be subject to a total failure; for a panic due to a sudden failure on a busy night might be a most serious affair, involving the risk of damage to person and property. Apart from this, the loss of business entailed by lack of light would be considerable. Modern gas lamps are generally used for the main lighting of these buildings.

ECONOMY.

The cost of the general lighting is another factor which has to be taken into consideration by those who have to find the money to pay the bill. While it would obviously be unsound policy to be niggardly in the amount of light provided in a market, to pay a higher price than is necessary for the desired quantity of light would be a step in the wrong direction. For any required amount of light, gas is most effective and economical when used in conjunction with the super-heated low-

FIG. 3.—One of three beautifully illuminated avenues in Euston Market, London, N. The super-heater cluster-burner gas lamps chosen for this purpose give a brilliant light without glare, and are at the same time dignified in design. All of the lamps in this avenue are lighted up simultaneously by the turning of one of the control cocks to be seen in Fig. 6.

pressure cluster-burner lamps or high-pressure gas lamps; and the maintenance costs are reasonably low.

EFFICIENT MAINTENANCE ESSENTIAL.

A plan which is very often adopted in connection with these market installations of gas lighting is for the local gas undertaking to supply and fix the lamps and maintain the installation in perfect lighting order for a set charge per lamp per annum; the actual quantity of gas consumed, as registered by the meter, is paid for by the proprietor. In other cases the gas undertaking will agree to instal the lamps, supply all gas required for a given number of hours per annum, and maintain the fittings in good lighting order at an inclusive charge. These arrangements will vary slightly in different districts, but in any case no difficulty should be experienced in fixing up some mutually convenient arrangement whereby the skilled men of the local gas undertaking keep the installation in perfect condition at a reasonable charge.

THE LIGHTING OF FULHAM MARKET.

A typical example of a successfully-run, covered-in market is the Fulham Market, situated in Walham Green, Fulham, London. Seldom, if ever, is there an empty stall. On certain days of the week the three main avenues are closely packed with customers, and even on the slacker days the business done is considerable.

This market is lighted by 25 powerful gas lamps of an attractive design, provided with frosted globes which ensure a well-diffused, soft light without glare (see Fig. 1). Each lamp contains a cluster of six medium-size gas burners, and consumes about 15 cubic feet of 500 B.Th.U. gas, or ·075 therms per hour. The burners are of the super-heater type. The pre-heating system involves no mechanical operations, and the burners and lamps are, therefore, in every way as reliable as their less efficient predecessors.

LIGHTING AND EXTINGUISHING THE LAMPS.

The market porter lights and extinguishes the lamps in series by the turning of control cocks placed in convenient positions. There are three control cocks in all. One cock turns on and off three lamps only, which are required to be alight when the shops are closed and the market is being cleaned. Each of the other two cocks operates a series of eleven lamps.

DISTANCE CONTROL DEVICE.

This distance control system is absolutely reliable, and can be used to light up and extinguish a complete installation of any number of lamps by the operation of a single tap fixed in the gas service at some convenient position; alternatively, the lamps can be controlled in series if a control tap is fitted in the service pipe to each series. When the lamps are out of lighting the by-pass jet on each lamp is kept alight by a small supply of gas which reaches it through the by-pass on the control cock, the service pipe and the device fitted on the lamp. As soon as the control tap is turned on, the gas pressure inflates a leather diaphragm in the small device fitted on the lamp (see Fig. 4), thereby lifting a valve and allowing a full supply of gas to reach the mantles. At the same time the leather diaphragm lifts the by-pass valve in the device into its seating, and the by-pass supply is thus shut off; but a very small amount of gas is still allowed to pass to the by-pass through a small hole below the valve seating, in order to ensure that the by-pass lights up a fraction of a second before the burner is turned out. The distance control device is suitable for shops as well as for large buildings. By simply turning a single tap a shopkeeper may at once illuminate the whole of his premises inside and out, although, as a matter of fact, it is more usual to have one tap to control the exterior lamps and another the interior lights.

LIGHTING THE STALLS.

The individual stalls in many of the markets have their own lighting installations. The requirements of the stallholders in this direction can best be met by gas lamps and burners of the super-heater type. An example of one of the gas-lighted stalls in Fulham Market is shown in Fig. 2. This installation was chosen because the gas lights used are fitted to serve a double purpose, namely, to light the stall and to keep the boiled sweets from becoming sticky. It will be noticed that the lamps are fixed only a short distance above the sweets; as a result, the heat radiated from the lamps prevents the

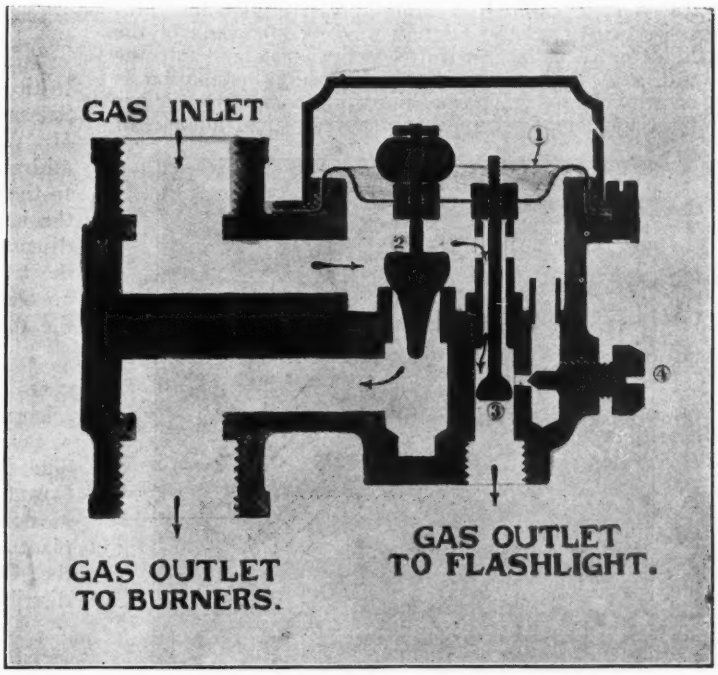


FIG. 4.—Sectional elevation of the small distance control device as fixed on the gas lamps used in the markets. The figures indicate: (1) Leather diaphragm; (2) main valve; (3) by-pass valve; (4) by-pass regulating screw. A description of the manner in which the device works will be found in the accompanying article.

FIG. 5.—The high-pressure gas lighting installation which illuminates the exterior of Euston Market, London. Each of the lamps gives a light of 1,500 candle-power. High-pressure gas lamps are particularly suited for the lighting of exteriors when it is desired to use high-power units at the lowest possible cost for a given amount of light.

surface of the sweets from attracting too much moisture from the air. It may be mentioned in passing that the heat from gas lamps is much appreciated by the stall-holders during the cold months, especially when their stalls are of the open-fronted type, and situated in draughty positions.

In almost every case the stallholder is supplied with gas through an automatic meter, which at regular intervals is emptied of its coins by the local gas undertaking.

EUSTON MARKET.

Another market lighting installation similar in many details to the Fulham one is that at Euston Market, London, a view of part of the interior of which is shown in Fig. 3. The interior lighting installation consists of 27 lamps, with four distance-lighting controls, some of which can be seen in Fig. 6. One tap is used to control the lamps along each of the three main avenues of the market; the fourth tap controls a few lamps which are required to be alight when the market is being cleaned up.

OUTSIDE LIGHTING.

The outside of this market is brilliantly lighted by eleven 1,500 candle-power high-pressure gas lamps provided with screens designed to direct the bulk of the light on to the large advertisement panels built into the walls. A night view of this imposing installation is shown in Fig. 5. The machine which compresses the gas for these lamps occupies only a very small amount of space. The lamps are turned on simultaneously by the starting-up of the compressor and the operation of the control governor fixed above the compressing plant. When a number of powerful lighting units are required for a purpose such as this, the initial expense involved in installing a compressing plant is often well justified, as the candle-power obtained from the gas used is higher than that obtained from gas at ordinary mains pressure. If the local gas undertaking has already laid a high-pressure gas main along the road, the gas can, of course, be taken direct from this main, and the need for a local compressing plant does not arise.

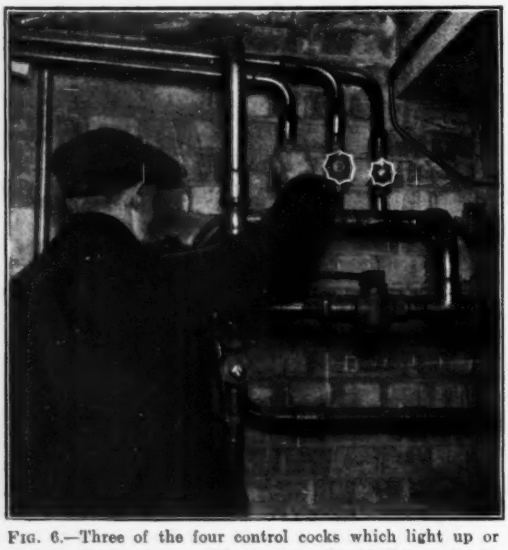


FIG. 6.—Three of the four control cocks which light up or extinguish the lamps illuminating the interior of the Euston Market, London, N. A night view of one of the avenues in this market is shown in Fig. 3. This system of distance control is absolutely reliable.

All of the gas lamps for the general lighting of the interior and exterior of Euston Market are kept in perfect order by the skilled men of the local gas undertaking, and the comparatively low cost of this service is more than justified by the excellent results achieved. These results can be partially judged by examination of the accompanying illustrations, but they can only be appreciated to their full by a visit to this market at night-time.

News from the Gas Industry

At a joint meeting of the Wales and Monmouthshire Institution of Gas Engineers and Managers, and the Salesman's Circle, held in Cardiff on February 18th, Mr. W. M. Mason (Manager of the B.C.G.A.) gave an address entitled "A New Spirit in an Old Industry." In the early part of the address Mr. Mason emphasized the importance of the spirit of service, after which he discussed in turn housing problems, hotel equipment, the treatment of hotels, theatres and clubs, and gave an outline of some of the recent propaganda work of the B.C.G.A.

* * *

On January 25th the gas centenary at Walsall was celebrated by an official inspection of the Pleck Gas-works, followed by a luncheon in the Council House. The day was concluded by the formal opening of a Gas Centenary Exhibition at the baths. To commemorate the centenary and the inauguration of the new plant an illustrated booklet, prepared by Mr. F. Davies, the Corporation Gas Engineer and Manager, was distributed.

* * *

The Abercarn Urban District Council recently opened new showrooms at Newbridge. A novel feature was the exhibit, in the window, of an incubator where the value of gas heating in assisting the rearing of young chicks was illustrated.

Some Notes on the Ideal Home Exhibition

Held at Olympia, March 2nd to 27th, 1926

By AN ENGINEERING CORRESPONDENT

ONE usually looks to the Ideal Home Exhibition for an indication of the trend of progress in domestic lighting, and the present exhibition was in some ways specially interesting in this respect. Much has been said in criticism of the lighting of exhibitions of past years. On the whole, one may say that recent exhibitions show progress. In this case there were few instances of really glaring lights, and some examples of stall-lighting which were quite effective.

Dealing first with the main general exhibits, one is inclined to single out the display of "Kitchens of the Nations" as one of the most popular. Although relegated to the gallery, and in a somewhat confined space, it attracted much attention, and the imitation of kitchens (English, French, Dutch, Danish, Swedish, Spanish, Chinese, American, etc.) was ingenious. The exhibits were housed in adjacent small booths, and all were illuminated by concealed lamps, in the approved method of treating shop windows. Apparently, too, the illumination was adjusted according to the period—at any rate, the modern American kitchen appeared, quite properly, brilliantly illuminated in comparison with the old designs of Denmark, Norway and Spain.

The various model houses in "The Village of Open Doors" afforded good opportunities of examining modern methods of furnishing and lighting fittings. While it might be said that the latter did not always indicate the last word in efficiency, they were in the main suitably placed and free from glare. The "Gardens of Enchantment" again presented a delightful spectacle. Not only were the gardens works of art, but the provision of an illuminated background, with painted distant hills, etc., did much to set off the effect of the flowers. On this occasion the main lighting was provided by lamps in diffusing globes, hung beneath the canopy; whilst it cannot be said that these supported the impression of being in natural daylight, they were at least screened and placed at a good height, out of the range of direct vision. On a future occasion one would like to see a more serious effort to imitate daylight—possibly by the use of the Restlight or other special screen, or by indirect lighting of a painted canopy, forming an artificial sky.

In the Heating and Lighting Section attention was naturally attracted by the adjacent London Gas Exhibit and the display of the British Electrical Development Association. The former consisted of six model rooms and a lounge, the applications of gas for lighting and heating being shown in an attractive way. One of the most noteworthy instances of recent progress in gas lighting, to the author's mind, is to be found in the small and dainty bijou bracket burners, equipped with a shade which gives a pleasing and soft light, and vastly superior to the similar fittings available a few years ago.

The Electric House contained the familiar series of rooms illustrating applications of electricity, but a new feature was added in the provision of two sets of rooms, contrasting respectively the conditions in a kitchen and living-room fifty years ago and to-day. The rooms of the former period were faithful reproductions, even to the oddments on woollen mats and the whiskers of the gentleman by the fireplace! The lighting, by old-fashioned oil lamps, was of course extremely dim in comparison with the illumination in the modern rooms lighted by electricity.

Other methods of lighting besides gas and electricity were also well represented. On the stand of Aladdin Industries Ltd. there was a complete range of Aladdin Incandescent Paraffin Lamps, of which, it is stated, no less than eight million are already in use. It may be recalled that these lamps burn a mixture of 94 per cent. air and 6 per cent. paraffin, and they are regarded as absolutely safe, as in the event of an upset the lamp is at once extinguished. A variety of forms, pedestal and bracket, besides pendant lamps, were on view; likewise the familiar Aladdinette Everlasting Candles and Night-lights. Other exhibits included Aladdin Artesque Painted Furniture, etc.

Other illuminants represented included petrol-air gas, as exemplified by Spenser's "Silverlite" plant, and the Aerogen system. Messrs. Worsnop & Co. had on view the Petrolite Safety Lamps, and Messrs. Thorn & Hoddle a display of acetylene lighting. Electric country-house plants included the Delco-Light, an automatic set operated by a petrol engine.

FIG. 1.—A drawing-room of 50 years ago.

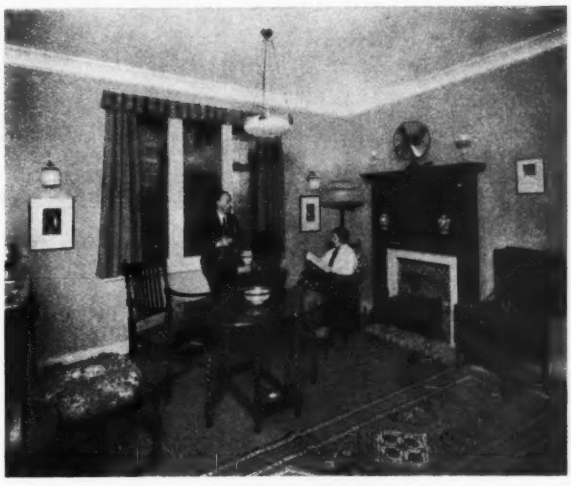


FIG. 2.—A modern drawing-room.

Amongst miscellaneous lighting fittings we noted the show of alabaster bowls by A. Martelli, a display of some very pleasing fittings and shades by L. G. Hawkins & Co. Ltd., and the Astro reflectors of the B.I. Syndicate, who also exhibited Violet-Ray Apparatus and Daylight units. A variety of lighting fittings was also shown by the Artisco Co. Ltd., and the Sheringham Daylight, often referred to in this journal, was also on view.

This by no means exhausted the list of exhibits of lighting appliances. Many instances of decorative silk shades were to be seen in the Arts and Crafts Section, such appliances now forming an essential element in the work of most firms who deal with decoration and furniture for the home.

An Extensive Industrial Lighting Installation

THE two accompanying photographs, which are reproduced from *Holophane Illumination*, show the methods of lighting introduced into Messrs. Joseph Lucas & Co's extensive works at Birmingham. When the general lighting of these works was being considered, it was decided to take some photometric tests on various units and to ascertain the most efficient unit which was to be adopted as a standard throughout the works.

The outcome of the above tests was that Holophane units were selected, and the first shop to be equipped was the Armature Winding Shop. Holophane AE.150 units were installed in conjunction with 200 watt gas-filled lamps for general lighting. In addition, owing to the very fine nature of the work in this shop, the above installation was supplemented with local units over the winding machines. The approximate intensity on the machines is 40 foot-candles.

After this installation, various other sections of the works were equipped in a similar manner but without any local lighting. These sections consist of various types of machine shops and a standard spacing has been adopted throughout. The following details may be of interest:—

Spacing	13′ 7″ × 11′ 7″
Height above floor	9′ 6″
Working Plane	3′ 3″
Lamp Watts	200
Units	AE. 150

The factory in question is a six-story building, and for departmental purposes is divided into blocks vertically, *i.e.* there are six floors to one block, and the following facts may be noted:—

The area of a floor is	9,575 sq. ft.
Total floor area in one block	57,450 ,, ,,
Number of units per floor	65
Number of units per block	390
Number of Watts per floor	13,000
Number of Watts per block	78,000
Watts per sq. foot	1·36
Illumination intensity	10·0 ft.-candles

As the total amount of current consumed by this firm is considerable, they are put on a special rating, and the cost of lighting the whole block works out at 6/- per hour, which must be considered a very economical result. All the other blocks are of a similar size, so that the above data apply throughout. The number of units supplied to date is in the neighbourhood of 2,000.

It may also be mentioned that there are several smaller buildings, such as plating shops, which have likewise been equipped with Holophane, but in most of these cases units of a smaller size have been installed.

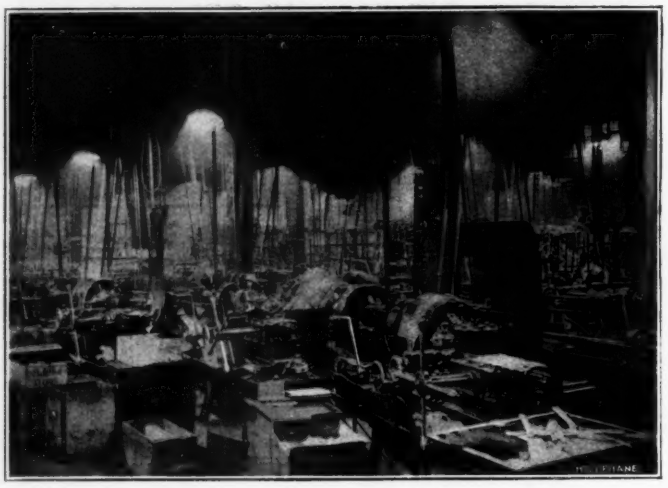


FIG. 1.—A machine shop at Messrs. J. Lucas & Co.'s works (night photograph).

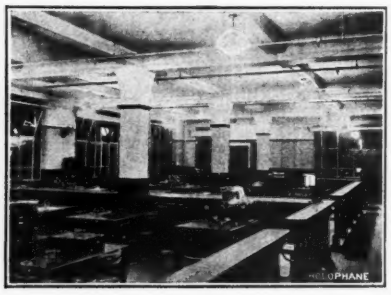


FIG. 2.—The main office of Messrs. J. Lucas & Co. Overhead Lighting with Holophane Refractor Units, which combine the main characteristics of direct lighting with a high standard of diffusion, has been introduced. A feature is the even illumination over the whole working area, which enables the latter to be used irrespective of the position of desks.

Lecture on Lighting in Aberdeen

A lecture on "Modern Illumination" was delivered at Marischal College, Aberdeen, by Mr. Henry E. Hughes, District Engineer of the Scottish Electric Lighting Service Bureau of Glasgow, on Friday, February 26th. The lecture was given under the joint auspices of the Aberdeen Association of Civil Engineers, the Society of Architects, and the Mechanical Society, and Mr. J. Alex. Bell, M.Inst.E.E., M.I.Mech.E., Engineer and Manager of the Aberdeen Corporation Electricity Department, was in the chair.

Mr. Hughes dealt with the evolution of light sources from the most primitive to the modern lamp, and remarked that artificial light had been one of the greatest civilizing agents. But it must be wisely used.

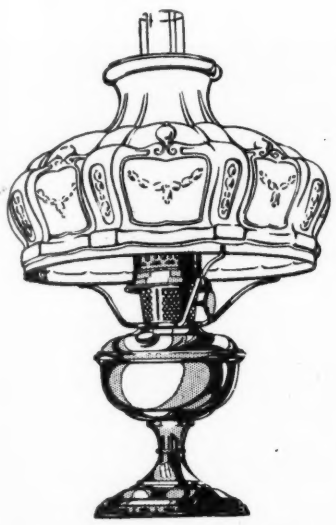
Glare resulted from the use of the modern gasfilled lamp required to be used in a manner different from that applying to lamps of lower brightness and efficiency. In order to eliminate glare, he advocated the use either of diffusing enclosed units or "white-sprayed" bulbs. Some striking demonstrations, aided by a series of lantern slides, proved the advantages of scientific illumination over ordinary unscientific lighting. The rapid coming of the Electrical Age in Great Britain was foreshadowed by the lecturer, as also was the probability of the arrival of still more highly efficient lamps in the future. A good discussion followed, illustrating the interest now being taken in illumination in Aberdeen.

Electric Light in Agriculture

In a recent issue we referred to some data given by Mr. R. Borlase Matthews on the application of light in horticulture. In a paper recently read before the Institution of Electrical Engineers he mentions that by applying intense illumination three or four weeks' growth was obtained in four to seven days. Poultry-house lighting is now a recognized commercial practice, seeing that an increase of 15 to 43 per cent. in the egg production during the winter months can be obtained during the winter months, when prices are highest. The birds are not in any way strained by artificial lighting, as they get 10 hours' sleep each night. They are simply allowed ample time for feeding, as in the sub-tropical country where they originated, instead of being partially starved owing to the long winter nights in this country. A novel application, which is still in the experimental stage at East Grinstead, is the electric lighting and heating of bees in hives, kept indoors instead of in the open. By this treatment strong hives are obtained at the time when the orchards are in bloom. As a result, about an additional 17 lb. of honey can be secured per hive per annum.

A remarkable paraffin lighting achievement

The Aladdin Incandescent Paraffin Lamp gives a better light than either gas or electricity



The Aladdin light is a very distinct achievement in lighting. It burns 94% and only 6% paraffin, and costs less than a farthing an hour to burn. There is no pumping needed, and because there is no pressure there can be no question of the lamp exploding. If it is knocked over, it merely goes out. There are no fumes, no odour and no noise. The light is absolutely silent and flickerless, and is entirely harmless to the eyes.

As was only to be expected, the lamp has been imitated. But so poorly that the difference between the original Aladdin light and the copy is quite obvious. This extraordinary light is available in a great variety of models, with beautiful silk and vellum shades in designs and colours to harmonise with any furnishing scheme. The Cottage Model—the most popular—sells at 42s. (without shade). Further details will be gladly supplied on request.

Aladdin

incandescent paraffin lamps

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Now is the time to give your orders for the wonderful all-British-made glass "HAILGLASS." We allow ample discounts to the trade. We are on the spot and can give quick delivery and perfect satisfaction. Have a look at the stock in our showroom on entresol 32, Shaftesbury Avenue, London, W.1. You will be surprised at what we are making, and how well we are doing it.

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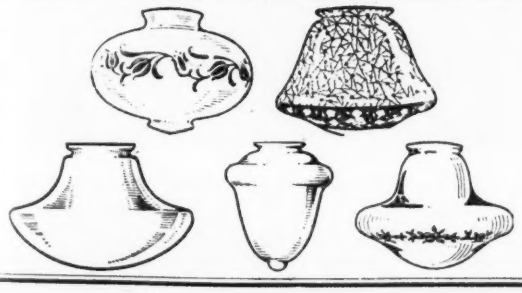

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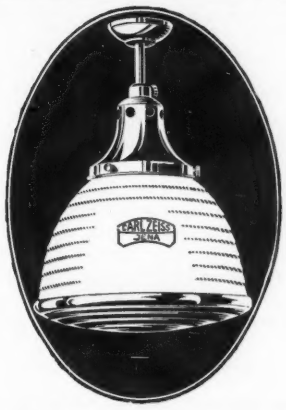

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In efficiency, as in appearance, it is unique

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TRADE NOTES & ANNOUNCEMENTS

FLOOD-LIGHTING OF THE BUSH HOUSE.

The Bush House, Aldwych, London, has often been mentioned as one of the most imposing office-buildings in London, owing to its size and commanding position. The entrance is on bold lines, and the accompanying illustration, reproduced from the current issue of *The Osram Bulletin*, gives an effective impression of its appearance by night. As an example of flood-lighting it has several unusual features—notably the device by which the figures above the pillars are shown in relief with a luminous background. Apart from the use of G.E.C. flood-lights for this special display, the building affords opportunities for lighting on a vast scale. It is stated that over 2,000 Osram lamps are employed in the numerous palatial offices, with a total wattage of 122,380. In some of the rooms G.E.C. alabaster fittings are also used.

BENJAMIN OFFICE LIGHTING.

The most recent issue of *The Benjamin Bulletin* contains several attractive pictures of large offices lighted on Becolite and Biflector fittings, the former being a particularly successful photograph, taken by the unaided light from the fittings shown. There is also another illustration showing effective lighting with the Benjamin Elliptical angle reflectors, whilst on the back of the leaflet is a reproduction of the "correct lighting chart," to which reference was recently made in these columns.

Another recent leaflet issued by the Company contains a circular letter pointing out the importance of good lighting in printing works; copies of communications expressing approval of results obtained with Benjamin units are included.

SIEMENS MONTHLY LIST FOR MARCH.

The Siemens Monthly List for March is, as usual, a comprehensive one. Particulars of the complete range of standard lamps are given, and leading types of fittings, including reflectors and enclosed dust-proof types, are shown. A wide range of electric accessories, "Zed" fuses, wires and cables, batteries, etc., is also listed.

PHILIPS LAMPS LTD.—NEW OFFICES AND SHOWROOMS.

We had recently an opportunity of calling at the extensive new offices of Messrs. Philips Lamps Ltd., at 145, Charing Cross Road, where work is now busily in progress. The new showrooms in the vicinity are making rapid progress, though some little time will elapse before they are quite ready for public inspection. We were interested to learn that besides the display of lamps special arrangements for demonstrations of various kinds will be made, so as to be completely in line with modern developments.

CONTRACTS CLOSED.

The following contracts are announced :—

METRO-VICK SUPPLIES LTD. :

Southern Railway; part contract for "Cosmos" Gas-filled, Vacuum Metal Filament, Train-lighting and Carbon Filament Lamps, for six months, March 1st, 1926, to August 31st, 1926.

MESSRS. SIEMENS and ENGLISH ELECTRIC LAMP CO., LTD. :

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Showing the Flood-lighting of Bush House, Aldwych, London.

THE PRINCE OF WALES AT THE BRITISH INDUSTRIES FAIR.

On the occasion of his visit to the British Industries Fair at Birmingham on February 23rd, the Prince of Wales was welcomed to the Electrical Section by Sir Hugo Hirst, Bart., the chairman and manager of the General Electric Co. The accompanying illustration shows the Prince with Sir Hugo Hirst and Dr. Railing on the G.E.C. stand.

In conversation with Sir Hugo, the Prince recalled his visit to the Witton Works of the G.E.C. during his industrial tour of the Midlands in 1924, and expressed his gratification at the fact that the Company found employment for over 20,000 workpeople.

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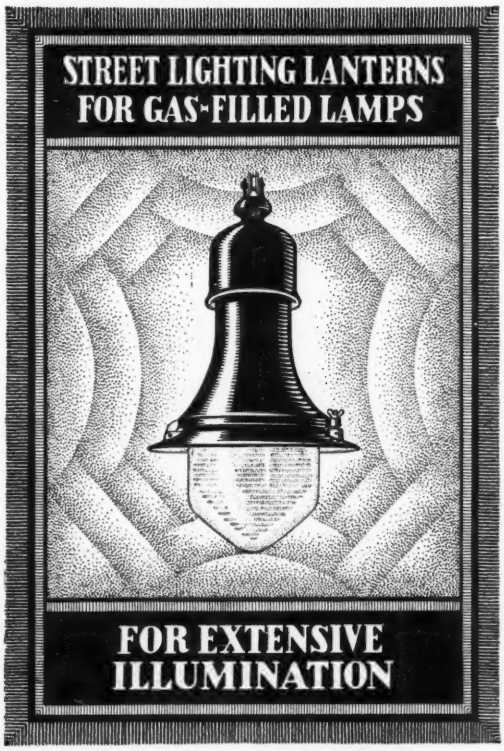

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REVIEWS OF BOOKS AND PUBLICATIONS RECEIVED

COMMISSION INTERNATIONALE DE L'ECLAIRAGE; RECUEIL DES TRAVAUX ET COMPTE RENDU DES SEANCES. *Publié sous la Direction du Bureau Central de la Commission, The National Physical Laboratory, Teddington, Angleterre.* (*Cambridge University Press*, 1926; *pp.* 432; 15*s. net*).

The official account of the proceedings at the last meeting of the International Illumination Commission, held in Geneva during July, 1924, is an imposing production, and illustrates the manner in which the work of the Commission is extending. As a frontispiece a photograph of the delegates, with diagram showing their respective names, is presented. Following this, we have the official account of the proceedings, in French, and the record of the decisions taken, including a summary of the chief terms and definitions and symbols adopted for quantities used in illuminating engineering. An appendix contains the report presented by Mr. L. B. Marks (Chairman of the Committee) on the lighting of schools and factories. This is divided into two sections dealing respectively with schools and factories, and the suggestions are conveyed, in accordance with the decision of the Commission as "Minima Recommended," and not as "Minima Required."

After this we come to the various papers presented, reproduced either in French or in English, according to the country from which they emanated. The initial summaries of the contents of papers are, however, given in three languages, French, English and German, which is a useful step. These cover a very wide ground, a notable feature being the inclusion of quite a number of communications dealing with the more practical aspects of illuminating engineering.

The first paper, by Dr. H. E. Ives, summarizes recent experiments made in the United States with the object of developing a primary standard of light, based on the maintenance of a black body at a prescribed temperature of incandescence. M. Jules Baillaud deals with various standards used in sensitometry; Messrs. Forsythe and Worthing with Properties of Tungsten and their application in electric lamps. Professor A. Blondel presents suggestions for nomenclature, symbols, etc.; and Monsieur Ch. Fabry reviews heterochromatic photometry; Monsieur R. Jouast deals with an allied problem, the use of screens to facilitate comparison of sources differing in colour; and there is an interesting review of work carried out at the N.P.L. on Colour-temperature and Luminosity Efficiency Relations for Tungsten, by Messrs. H. Buckley, E. J. Collier, and F. J. C. Brookes. All these papers are of a scientific character, and refer to original work; in several cases they are accompanied by a useful bibliography.

We come next to a new feature in the gatherings of the Commission—the correlation of the activities of those concerned respectively with the technical and practical aspects of illumination. In this section the three papers read by Messrs. John W. Lieb, A. L. Powell and G. S. Merrill illustrated the practical co-operation of central stations in educational propaganda in favour of better lighting, and showed the recognition on the part of American electric supply undertakings and manufacturers of the great value of illuminating engineering in their work—a view that was fully endorsed by those present. Monsieur H. Laurain and Monsieur J. Mariage deal respectively with the lighting of Paris by gas and electricity. Both are illustrated and contain much interesting information. Another contribution of special interest at the present time is Monsieur J. F. Cellerier's account of the use of luminous signalling for the guidance of traffic.

The next group of papers deals with the lighting of factories, schools, etc. There are Mr. Leon Gaster's contribution, "Some Further Developments in Industrial Lighting in England"; a paper by Professor U. Bordoni dealing with the Phenomenon of Glare; and reports presented by Mr. L. B. Marks and Monsieur Maurice Leblanc on the Lighting of Schools and Factories. The former contains the report of the Committee mentioned above in the first paragraph, which served as an introduction to the recommendations already referred to. Dr. C. H. Sharp and Monsieur Pierre Bossu discuss the problem of regulations for motor-car headlights. Finally, there is a contribution by Mr. H. Buckley, entitled "The Field for International Agreement and Standardization in Illumination."

It will thus be seen that the papers fall into well-defined groups, and illustrate the great amount of attention now being devoted in all the chief countries to illumination. The assembly of this volume must have involved a considerable amount of work, and congratulations are due both to those responsible for the editing and to the Cambridge University Press for this well-printed publication.

ABSTRACT BULLETIN OF THE NELA RESEARCH LABORATORY; *Vol.* 1; *No.* 4, *December*, 1925; (*pp.* 746).

This summary of work carried out at the Nela Research Laboratory (Cleveland, U.S.A.), is, as usual, well printed and illustrated. A considerable proportion of the researches summarized are concerned with pyrometry, photometry and radiation from incandescent materials, so that these have a certain bearing on incandescent lamps. There are, however, many others that are purely scientific, such as those concerned with bioluminescence, colour vision, various researches on the effect of light on starfish and other organisms.

Many of the experiments described well deserve study. Dr. Hyde, E. P. Hyde, and F. E. Cady describe an ingenious method of increasing the sensitiveness of the Lummer Brodhun photometer. Professor P. W. Cobb is responsible for several investigations connected with the powers of the eye, and Mr. Luckiesh contributes an interesting discussion of aerial photometry and the visibility of aeroplanes. Other notes deal with improvements in measuring apparatus. There are 138 investigations in all—physical, chemical and psychological. The Nela Research Laboratory is associated with the incandescent lamp department of the General Electric Co. (U.S.A.), and the company is to be congratulated on affording facilities for so much varied research work, much of which might be regarded as a contribution to the advancement of "pure science."

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SIXIÈME SESSION
Genève—Juillet, 1924

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THE COAL REPORT AND THE SMOKE PROBLEM.

To the Editor.

Sir,—The insistence of the Coal Commission upon research, and more research, into the development of scientific methods for the use of fuel makes it clear that the Commissioners regard the old era of the coal industry as closed. We are no longer to consider that coal mining means finding and digging up stuff that will burn, tossing it into a truck, and letting the consumer do what he likes with it. The treatment of the fuel in such a way as to get out of it the greatest advantage for the community is to be the avowed object of the industry in the dawn that is to follow the darkness of the present depression.

One of the advantages anticipated from the more scientific treatment of the fuel problem is the riddance of smoke, even in great towns. The fact disclosed by the Commission's report that soot discharged into the atmosphere annually represents three days' output of all the mines in the country (employing over a million men) provides a simple but vivid illustration of the waste due to burning raw coal.

After years of research and experiment the way towards freedom from smoke is now pretty clear—smokeless methods in factories and smokeless fuel in domestic use. Hitherto we have always been waiting for something, and at the moment we are waiting for a fuel to take the place of about forty million tons of raw coal burned (in 1923) in domestic grates. Those who know tell us that if we want a smokeless fuel we have got to make it, and making forty million tons of anything is, of course, an industrial undertaking on a vast scale. It can only succeed commercially if the value of the products exceeds the cost of making them. That is, in brief, the position of the question of carbonization of coal at low temperature. The question has claimed so much attention, as such a system is needed for domestic use in addition to anthracite, coke, gas and electricity.

At the recent Clean Food Exhibition Mr. Neville Chamberlain appealed to housewives to supplement the proposed Smoke Abatement Bill, and set an example which might be followed by local authorities. Housewives can do much, if not everything, without the help of husbands and landlords. Perhaps, in time, Government itself might realize the possibility of putting its own houses in order.

What is now added as an inducement is that the coal industry of the country will be helped towards renewed success by attention to the proper use of fuel; and the use of fuel to make smoke is from now onwards to be regarded as improper.

I am, etc.,

(Signed) NAPIER SHAW.

15th March, 1926.

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